

# SCIENCE

12 April 1957

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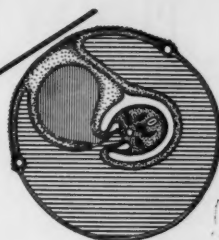
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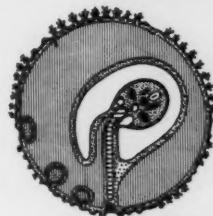
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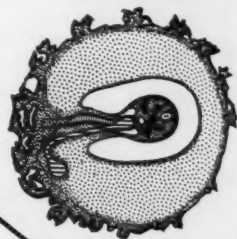
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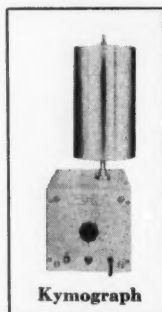


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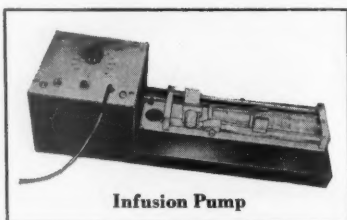


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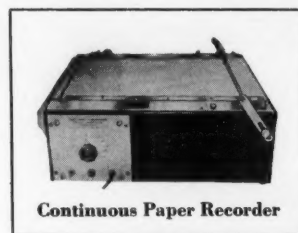


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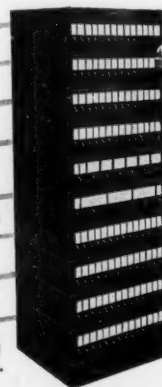
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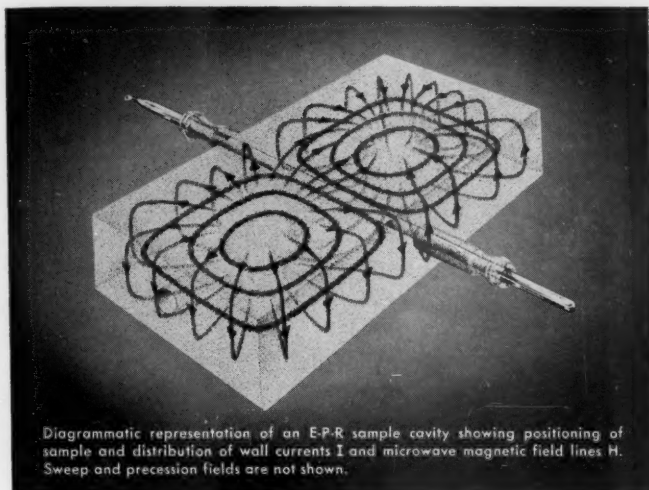
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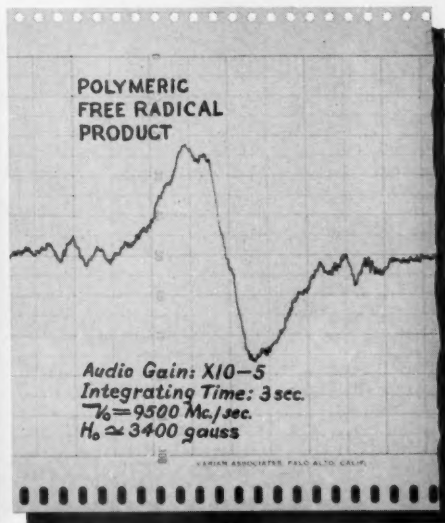
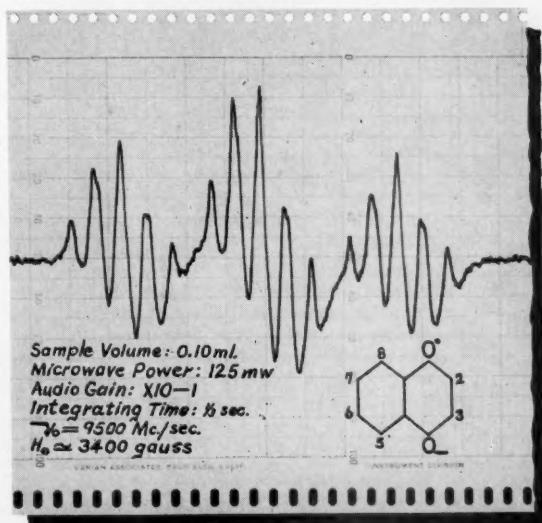
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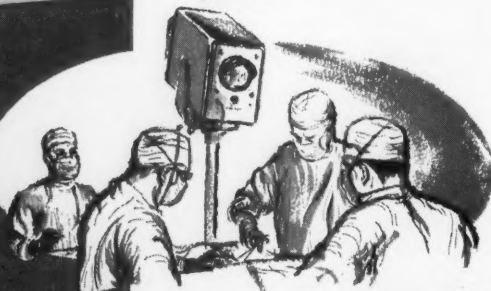
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## Canard Corrected

Last autumn many newspapers and *Science* [124, 882 (2 Nov. 1956)] published the statement of the Medical Examiner of Philadelphia, Joseph W. Spelman, about the death of Kenneth A. Koerber, a physician who had worked in the Medical Department of Brookhaven National Laboratories from June 1947 to August 1948. Spelman attributed Koerber's death to excessive radiation exposure at Brookhaven and stated that his bones contained "1000 times the maximum safe concentration of radiation."

This was a startling statement and one that, if true, would have grave implications for anyone engaged in work in the atomic energy program. The Atomic Energy Commission began an immediate study of the case in an attempt to answer two questions. First, could Koerber have received a fatal dose of radiation while he was at Brookhaven? According to Lee E. Farr, Medical Director at Brookhaven, at the time Koerber worked there construction of accelerators had not begun, the reactor had not been loaded, and no radioactive substances were in use in the Medical Department. Small amounts of tracers for use in biological and chemical studies were in use in two departments. Under these conditions Koerber could not have absorbed any significant amounts of radiation, and the answer to the first question is *No*.

Second, did Koerber die of radiation poisoning? Specimens of his bones and liver were sent for study to Argonne National Laboratory, which is operated for the AEC by the University of Chicago. Elaborate tests carried out there showed an essentially normal amount of radioactivity or, in the language of the laboratory report, showed "appreciably nothing above the activities to be found in contemporary man due to fallout and natural sources." It is apparent that the answer to the second question is also *No*. Koerber's death could not have been brought about by an excessive dose of radiation as claimed by the Medical Examiner of Philadelphia.

We are glad to do what we can to bring out the facts in this disturbing case. As atomic reactors go into action and the testing of weapons continues, we may from time to time expect to read similar scare stories, couched in equally extravagant language. We recommend an attitude of skepticism until an assessment can be made on the basis of the best information available.

Perhaps the best source of current information about the immediate hazards and the control of atomic radiation is the *Twenty-first Semiannual Report of the Atomic Energy Commission*. It describes in detail the steps taken to protect workers in atomic installations and those taken to protect the public by monitoring fallout and by disposing of radioactive wastes safely. Of the many thousands of people who have worked in the atomic program during the first 11 years of the existence of the AEC, 69 have been exposed to excessive amounts of radiation, and of these two have died as a consequence. That there have been any injuries and deaths is regrettable; that there have not been more in so vast an operation is remarkable.

—G. DuS.



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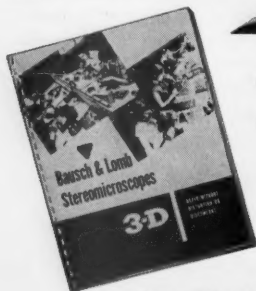
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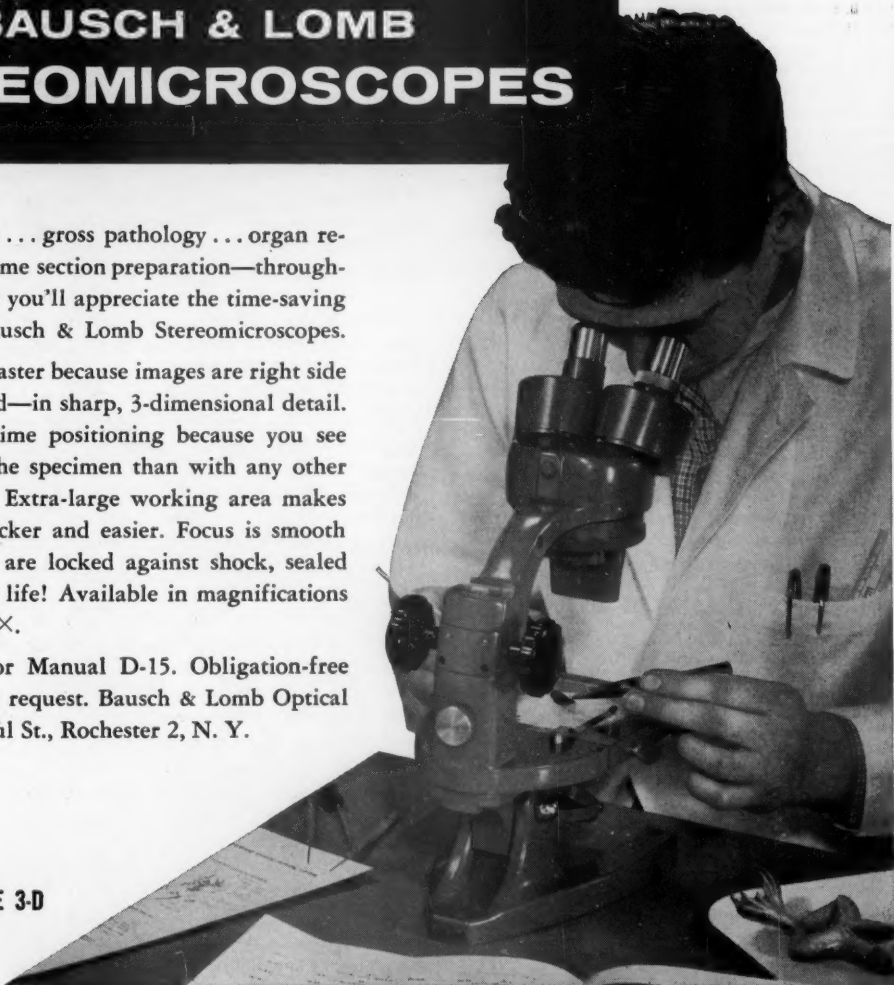
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SCIENCE, VOL. 125



## Chemical Kinetics in the Past Few Decades

Cyril Hinshelwood

The task before me is to speak of the evolution during the last few decades of the branch of physical chemistry which treats of the intimate mechanism of chemical reactions. The present circumstances seem to call for a survey taken from a rather more personal point of view than is usually desirable or proper. Hence, it is perhaps suitable that I should give some account of the lines of thought and of the accidents which have determined the course of the work in which, with others, I have taken part.

Nobody, I suppose, could devote many years to the study of chemical kinetics without being deeply conscious of the fascination of time and change: this is something that goes outside science into poetry, but science, subject to the rigid necessity of always seeking closer approximations to the truth, itself contains many poetical elements.

There are many ways in which the mysteries of chemical change might begin to impress themselves on a young chemist. I will mention one: it belongs to practical life and is a real example. Explosives have to be tested for stability, and this is done by measuring their decomposition at a suitably high temperature. Phenomena of great interest appear, revealing a remarkably large influence of temperature, a great acceleration of the rate if the solid liquefies, and various striking catalytic effects. Many major problems present themselves,

which can be roughly summed up as those involving the dependence of chemical change on the energy and the environment of the molecules. It was obvious that these problems offered many mysterious and fascinating aspects. In fact, they prove to contain more than enough for a lifetime's study.

### Unimolecular Reactions

In the early 1920's, one of the central questions in physical chemistry was that of unimolecular reactions, in which interest had been newly roused by the idea that such reactions were provoked by the absorption of radiation. A curious circumstance is that much theory was centered on the category of unimolecular reactions in the gas phase, of which in 1920 no authentic example was actually known. The much-discussed decomposition of phosphine proved to take place on the vessel walls, a fact linking up with the renewed interest in heterogeneous catalysis of gas reactions which the work of Langmuir on reactions with heated filaments had awakened. Against this background, work in Oxford became directed to two ends: (i) the discovery of new homogeneous reactions, and in particular those of single molecules, and (ii) the study of the factors which made the mechanism of heterogeneous catalysis often the preferred one.

The study of the heterogeneous reactions revealed one principle, which now seems trite enough, but which was very stimulating in the days when molecular mechanisms of chemical changes were largely wrapped in mystery—namely that

the affinity of the solid catalyst for part of the reacting molecule opens a reaction path with lower activation energy. Examples of homogeneous changes multiplied, and a new field opened up when thermal decompositions of organic vapors such as acetone, ether, and acetaldehyde proved to be a rich source of unimolecular reactions.

Like the famous example of the dissociation of nitrogen pentoxide, which was investigated by Daniels and Johnston in 1921, all these reactions eventually proved to have mechanisms of a much more complex character than was at first supposed. Two major findings have, however, stood the test of time. First, there was the unmistakable evidence that molecular collisions play the all-important role in communicating the activation energy to the molecules which are to be transformed and, second, there was the recognition of the activation energy (derivable from the Arrhenius law of temperature dependence) as a dominant, though by no means the sole, factor determining reactivity in general.

### Chain Reactions

These things helped to give shape and coherence to the whole subject of chemical kinetics. While the development of these themes was being pursued, a new one entered to add complexity to what was already complex enough—namely, the theme of chain reactions.

The principle of chain propagation had been enunciated by Nernst to explain large departures of photochemical reactions from Einstein's rule, and the possibility of its intervention in thermal reactions had been suggested by Christiansen. The first clear evidence that chain processes play a major part in thermal reactions in the gaseous phase came from the investigation of the unexpected properties of such reactions as the formation of water from its elements and the oxidation of hydrocarbons such as ethylene. Not only were the relations between rate and concentration inexplicable in terms of simple applications of the mass action law to nonchain processes, but the reactions also showed a quite surprising dependence on the size of the containing vessel, the presence of

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what should have been chemically inert gases, and the presence of sensitizers or inhibitors.

The reaction



from one point of view perhaps among the most elementary in chemistry, proved to offer a wealth of complex and intriguing behavior, not all details of which are even yet fully understood. Victor Meyer had thought it an interesting reaction to study, but found it, apparently, intractable. Bodenstein showed that at certain temperatures the union took place on the walls of the vessel. The work in Oxford started from the simple idea that, in the region of temperature between that used by Bodenstein and the inflammation temperature, homogeneous processes must come into play.

The now well-known phenomena of the lower and upper explosion limits were observed. Semenov, then in Leningrad, had just explained the sharp transition from negligibly slow reaction to inflammation (a "lower limit") of phosphorus vapor by the theory of chain branching. It was soon clear that the lower limit with hydrogen and oxygen was of a similar nature. The branching was shown here to be controlled by the deactivation of chain carriers at the vessel wall, and the "upper limit" was proved to depend on the removal of chain carriers by three-body collisions in the gas phase.

The study of the hydrogen-oxygen reaction was the first point at which the work in Oxford came into close contact with that of Semenov. Our indebtedness to his ideas was at once recognized, and the early exchanges opened friendly relations between Semenov and myself which have lasted ever since. I should like at this point to mention also my personal debt to an earlier great pioneer of chemical kinetics, Max Bodenstein, who himself plays a part in the curious history of the hydrogen-oxygen reaction.

The phenomena involved in the initiation, propagation, and termination of chains are now among the commonplaces of physical chemistry. Each process may be separately influenced by the conditions, so that the variety and complexity of the experimentally observable effects can no longer be wondered at. The detailed explanation of numerous examples continues to be of importance especially in connection with the control of the polymerization reactions that are widely used in the modern plastics industry.

### Thermal-Decomposition Reactions

The importance of thermal-decomposition reactions of organic molecules in connection with the fundamental theory

of chemical reactions has already been mentioned. Once chain processes were discovered, it was obviously necessary to know whether they were involved in the thermal decomposition processes. If so, the rather elaborate theoretical studies for which some of the results had been used would need considerable revision. A decision on this point was not quite simple. Work on the occurrence of free atoms and radicals, notably by R. W. Wood and Paneth, did indeed suggest the possibility of their intervention in such reactions as the ether decomposition, and Rice and Herzfeld formulated theoretical reaction schemes on this basis. On the other hand, tests for the actual presence of free radicals in the reacting systems which Patat and Sachsse made by the application of the *o*-*p* hydrogen method seemed at first to negative the idea.

Definite evidence was at length forthcoming when Staveley and Hinshelwood began to study the influence of nitric oxide on these reactions. The idea which initiated the work was simply that an odd electron molecule such as NO might well produce some interesting effects. Quite how interesting the effects would prove was not altogether foreseen. The pronounced inhibition caused by relatively minute quantities of this substance in a whole series of reactions which could conceivably involve the intervention of alkyl radicals left no doubt that the radical chain mechanism was in fact operative.

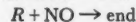
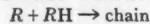
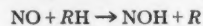
The working out in full detail of the mechanism of the large number of types of chain process now constitutes an extensive and elaborate chapter of chemistry which can absorb the attention of many workers for quite a long time to come.

The prevalence of chain mechanisms greatly complicates the problem of establishing a really complete and detailed theory of unimolecular reactions. Although a chain decomposition is often initiated by a unimolecular step, the observable kinetic relations are so much complicated by the varying possibilities for propagation and termination that definite conclusions about the details of the initiating process itself are very hard to arrive at. Some reactions, it is true, have been shown to be unimolecular without the participation of chains, but they are rare, and although the study of them is of great importance, it deals with a small minority of the examples presented by nature.

Great interest, therefore, attaches to the following problem. With increase in the amount of nitric oxide added to a system such as decomposing butane, the rate of reaction falls not to zero but to a definite limit. This limiting rate has been widely regarded as that of a unimolecular nonchain reaction—that is to

say, the dissociation of the butane into its stable products without the liberation of free radicals. If this view is correct, the butane decomposition, as well as a large number of other examples, can be used in the study of unimolecular reactions, provided that enough nitric oxide is added to suppress the chains.

But this view about the limiting rate is not without uncertainty. The alternative view is that the limit is determined by a steady state in which the nitric oxide starts as many chains as it stops



The arguments on the two sides are clear enough. That the limit corresponds to a molecular reaction is suggested by the following facts.

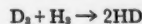
1) Inhibitors as different as nitric oxide, propylene, and *iso*-butene give just the same limit (though quite different amounts of them are needed to reach it).

2) The addition of certain foreign gases such as sulfur hexafluoride and carbon tetrafluoride accelerates the "residual" reaction in presence of nitric oxide by precisely the same absolute amount as these gases accelerate the much more rapid reaction occurring in the absence of the inhibitor, a fact suggesting that the uninhibited chain reaction and the residual reaction are independent entities.

3) The kinetics of the "residual" or "maximally inhibited" reaction show certain peculiarities which they share with other unimolecular reactions (notably the decomposition of nitrous oxide and the dissociation of di-*t*-butyl peroxide), known not to involve chains at all. The kinetic form would not be easy to interpret by the hypothesis of a nitric oxide-induced chain reaction, though it would be rash to assert that this could not be done with suitable ingenuity.

The argument on the other side is based chiefly on the fact that deuterium exchange in such systems as  $\text{C}_2\text{H}_6$ — $\text{C}_2\text{D}_6$  proceeds to about the same proportional extent whether the main decomposition is damped down by nitric oxide or not.

Although Rice and Varnerin reached this conclusion, Wall and Moore had found that the exchange was reduced by the addition of an amount of nitric oxide which was not sufficient to slow the decomposition to its limiting rate, and Stephen and Danby found that nitric oxide would in fact inhibit all the gas-phase chain reaction in the simple system



At present, my own support is for the view that the residual reaction is molecular, and that the experiments on deuterium exchange have other explana-

tions. This may, of course, prove to be erroneous. If so, nature has played a curious trick in arranging the coincidence whereby such varied agents can both start and stop chains with efficiencies which remain in a constant ratio. If this coincidence really does occur, then there is also a very puzzling problem to be solved in explaining the kinetic relations actually found with the maximally inhibited reactions themselves.

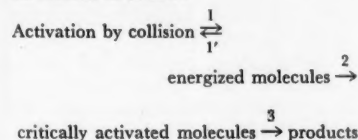
It is a rather strange position to defend a certain view because the stronger arguments seem to be in its favor, and yet clearly to realize what arguments there are on the other. Here, ironically enough, I may be wrong for maintaining that there is a nonchain component in some reactions which until the advent of the nitric oxide method could not be certainly proved to involve any chains at all. There is perhaps a moral in this to which I shall refer at the end. In the meantime, all kinds of detailed experiments are still going on to resolve this problem.

### Energy Distribution

Turning now to another question which has exercised attention from the very beginning, there are still puzzling and intriguing aspects about the value of the constant  $A$  in the equation which relates the rate constant of a unimolecular reaction to the activation energy

$$k = Ae^{-E/RT}$$

The processes by which the isolated molecule undergoes its first split, whether this is to be followed by a chain or not, seem to present a special interest both to theoretical and practical researchers. As we know, communication of energy by collision initiates a sequence which may be written as follows



At low pressures, process 1 determines the rate. At higher pressures, processes 1 and 1' are nearly in equilibrium. According to the simplest theoretical picture of the process, evolved by Rice, Ransperger, Kassel, and others and more recently greatly refined by Slater, the critical act in the whole sequence is process 2, which consists simply in the accumulation into one special bond of enough energy to rupture it. The mathematical analysis of this idea leads to the conclusion that  $A$  is of the order of magnitude of a molecular vibration frequency.

It sometimes is of this magnitude—a refreshing but not very common example

of nature's conforming to a simple pattern of behavior. (Incidentally, a good many of the "inhibited" paraffin decompositions, whose questionable status as primary unimolecular processes has been mentioned, conform very well.)

In other examples,  $A$  exceeds any likely vibration frequency by several powers of 10. Here it would certainly seem that the simple picture of a critical concentration of energy into one bond is inadequate, and I believe that, as a general proposition, this conception must be widened. The whole idea of the energy relations in unimolecular reactions has had quite an eventful history. First, the idea that the activation energy could not be communicated by collision had to be disposed of. Next, until it was realized that energy could be, as it were, mobilized from numerous internal degrees of freedom (in the process indicated by process 2 of the afore-mentioned scheme) there were misgivings about the adequacy of possible rates of energy transfer (and several writers even entertained the possibility that energy conservation did not apply in such processes). Then came the rather oversimplified view I have just mentioned, which is in course of being widened, so that we may now envisage many alternative states of energy distribution from which the final transformation may take place.

Another interesting set of problems has arisen out of the scheme of things set out in the preceding paragraphs. Process 1 is certainly rate-determining at the lowest pressures, and process 2 takes over at higher pressures. When one rate-determining process gives way to another, the characteristic plot of the first order rate constant  $k$  against the pressure shows a change of slope. In several examples, there are very strong indications that such transitions occur in more than one region of pressure. In other words, there are still further changes in the nature of the rate-determining process. The obvious interpretation is that process 2 involves further steps or even that process 3 may be collision-dependent. In the example of the decomposition of nitrous oxide, there is a considerable probability that the extra process introduced into the sequence is that of



These matters are still subjects of research.

### Reactivity and Structure

I must turn now to a quite different field of investigation, namely, that of the relationship between reactivity and structure. Here, perhaps, we may distinguish two main groups of problem. The first is one of a rather broad, indeed almost

philosophic character. In the equation for a reaction rate constant

$$k = Ae^{-E/RT}$$

or

$$\ln k = \ln A - E/RT$$

$\ln k$  is the kinetic analog of a free energy  $E$  of a total energy and  $\ln A$  of an entropy.  $E$  does indeed represent the energy required to lift molecules to the transition state, and  $A$  is concerned with the probability that all other requisites for reaction are fulfilled. Structural changes in reacting substances can affect both  $A$  and  $E$ . Sometimes, as is beautifully exemplified by the benzylation of a whole series of aniline derivatives containing different substituents, only  $E$  is affected. Sometimes, however, there is a deep inner correlation between the changes in  $E$  and the changes in  $\ln A$ , the completer understanding of which is now being sought, and it is to be hoped may reveal some more of the fundamental harmonies of nature.

The other great group of problems is that of the relation between changes in rate, whether expressed through  $E$ ,  $\ln A$ , or both, and electron displacements within molecules, the theory of which has been largely developed by organic chemists, and only very partially interpreted in terms of the quantum mechanical theory of valency.

Perhaps as samples of the interesting relations in the structural field I may mention one or two examples. The oxidation of hydrocarbon vapors, a very typical chain reaction, offers a rather remarkable one. The oxidation rate for  $n$ -octane is many powers of 10 greater than that of ethane, and detailed investigation shows the major influence governing the variations to be a very astonishing stabilizing influence of methyl groups which strongly discourage attack at any point of a hydrocarbon chain adjacent to them. This is, indeed, an elegant problem for theoretical structural chemistry.

Here are two more such problems for modern valency theory which experiment presents. In a reaction involving a benzene derivative, the rate is influenced by substituents in the ring, but to widely varying extents in different examples; and intriguing questions arise about the factors determining the ease of transmission to the reaction center of the substituent influence. The benzylation of aniline is slowed down hundreds of times by a nitro group, while the dissociation of nitrobenzaldehyde bisulfite compound differs little in rate from that of the parent substance.

When several substituents are introduced into aniline, their effects on the free energy of activation of the benzylation are almost strictly additive: in



other examples, the additivity is not nearly so evident, offering once again an interesting exercise for the theoretical chemist.

Perhaps I am beginning to indicate too many questions and too few answers, but to do this at least re-creates the general atmosphere of this whole subject.

### Living Cells

I am now going to turn briefly to a still more mysterious field, that of the living cell. With a subject like chemical kinetics whose ramifications and details multiply without end, the individual worker is always confronted with the choice whether to repeat, perfect, amplify, and consolidate, or whether to press forward into the completely unknown. In one respect, at any rate, a small group in Oxford has pursued the second course. The direction of this further exploration has been to seek an understanding of some of the kinetic phenomena of the living cell.

In some chemical systems, especially suitable for illustrating the elementary principles of kinetics, simple one-stage systems are met with, though less rarely than might have been hoped. In most of the systems easily accessible to experiment, reactions proceed by more or less complicated combinations of steps. In the living cell, a multiplicity of reactions is not just an unfortunate complication, but the essential condition for the phenomena of life to be possible at all.

Suppose we liken individual chemical reactions to so many simple musical themes each played on a different instrument. Then the operation of a living cell depends on the combination of all these elements into a symphony. Knowing something of the theory of the simple elements, can we find something about the rules of composition of the symphony?

To discuss properly the idea contained in this question would require not a small

part of one lecture, but a whole series of lectures. All I can do is to indicate certain facts and observations the following up of which brings us into contact with the major question.

Bacterial cells (and some other unicellular organisms) grow in very simple media at defined rates. They synthesize by long sequences of reactions all the complex components of their structure. When the chemical environment is changed, the growth rate alters. Gradually, however, by what is called an adaptive process, the cells undergo an internal reorganization in such a way that the rate, which may initially be very small, rises to a steady maximum. The detailed study of this process gives interesting information about the way in which the chemical reactions are linked into what we term the reaction pattern of the cell.

Inhibitory substances, such as drugs, frequently impede growth very seriously, but gradually the cells appear to learn to overcome this inhibition. Detailed study of this process shows it to be capable of a kinetic explanation about which, needless to say, some biologists are skeptical, but which helps to build up the picture of the cell's internal economy and to show how much this is determined by kinetic principles.

There are many other problems which can be envisaged in terms of the reaction pattern of the cell. Cells contain numerous specific enzymes. The way in which these are built up as the cells multiply has some curious aspects, of which the explanation is certainly linked with the mode of coordination of the reaction pattern. When cells are provided with nutrient, they grow and divide. The division seems to be determined by the moment at which a more or less critical amount of deoxyribonucleic acid has been built up. Here is a fact relating kinetic phenomena closely to structural considerations.

### Conclusion

I cannot give a full and coherent account of these things, but I mention them to show that there are plenty of mysteries left to explore, and also to suggest that kinetics can play a part in explaining some phenomena of that fascinating entity, the living cell. Even if I am wrong about this, it will have been worth the trouble to prove it.

One of my colleagues, G. Temple, has drawn an interesting distinction between the "classical" and the "romantic" in scientific research. The former is exemplified by the demonstration of clear-cut and unquestionable mathematical propositions, or the devising and application of crucial logical tests of alternatives, the latter by the exploration of the unknown and the formulation of provisional hypotheses from incomplete data which need continual revision as the search proceeds. There is little doubt to which class the study of chemical kinetics belongs. Indeed, some of us may well feel in retrospect like Dante:

*'mi ritrovai per una selva oscura  
che la diritta via era smarrita'*

[I found myself in a dark wood,  
Where the straight way was lost]

And, indeed, I mentioned earlier an example of a situation where one or the other of two quite respectable lines of argument must eventually prove to be in error. Is there a moral to be drawn? I am not sure, though we may perhaps console ourselves with the famous words of Lessing, "Nicht die Wahrheit, in deren Besitz irgendein Mensch ist oder zu sein vermeinet, sondern die aufrichtige Mühe, die er angewandt hat, hinter die Wahrheit zu kommen, macht den Wert des Menschen." Or, as an English writer has said, "To travel hopefully is a better thing than to arrive."





## Scientific Work of J. von Neumann

Even before the present age of specialization, few people have ever contributed significantly to several branches of science, and all of them have a permanent record in the annals of the history of science. John von Neumann made fundamental contributions to mathematics, physics, and economics. Furthermore, his contributions are not disjointed and separate remarks in these fields but arise from a common point of view. Mathematics was always closest to his heart, and it is the science to which he contributed most fundamentally.

John von Neumann was born in Budapest on 28 December 1903. He studied in Berlin, Zürich, and Budapest, receiving his doctor's degree in 1926. After serving as Privatdozent in Berlin and Hamburg, he was invited to Princeton University in 1930. Following 3 years there, he became professor of mathematics at the Institute for Advanced Study, a position which he held for the rest of his life. In 1955 he was appointed to the U.S. Atomic Energy Commission and served brilliantly in this post until his death on 8 February 1957.

The earliest significant mathematical work of von Neumann concerns mathematical logic, in which he was a forerunner of the epochal work of Gödel. His accomplishments can be summarized under two headings: axiomatics of set theory and Hilbert's proof theory. In both of these subjects he obtained results of cardinal importance.

Von Neumann was the first to set up an axiomatic system of set theory satisfying the following two conditions; (i) it allows the development of the theory of the *whole* series of cardinal numbers; (ii) its axioms are finite in number and expressible in the lower calculus of functions. Moreover, in deriving the theorems on sets from his axioms, he gave the first satisfactory formulation and derivation of definition by transfinite induction. Von Neumann's work on this subject already showed his power and the elegance of much of his later work. It contained a full clarification of the significance of the axioms with regard to the elimination of the paradoxes. He first showed how the paradoxes are related to the

theory of types and then proved that a set exists (this implies that it does not lead to contradictions) if, and only if, the multitude of its elements is not of the same cardinality as the multitude of all things. He also demonstrated that this proposition implies the axiom of choice.

With regard to Hilbert's proof theory, von Neumann clarified the concept of a formal system to a considerable extent. His articles contain the first unobjectionable proof for the fundamental theory that the classical calculus of propositions and quantifiers as applied to computable functions and predicates is consistent.

The work of von Neumann which will be remembered longest concerns the theory of the Hilbert space and of operators in that space. His papers on this subject can be divided into three groups: (i) the properties and structure of Hilbert spaces as such; (ii) studies of linear operators involving in essence only a single operator; (iii) studies of whole algebras of operators.

Von Neumann gave the first axiomatic treatment of Hilbert space and described the relation of Hilbert spaces to all other Banach spaces. A good exposition of his point of view on linear spaces is given in his book on functional operators.

In a remarkable paper, von Neumann gave the complete theory of extensions of Hermitian operators  $H$  on Hilbert space to maximal and self-adjoint operators, by means of the Cayley transform  $(H + iI)(H - iI)^{-1}$ . By the same transform, he established the spectral theorem for self-adjoint operators; that is, he constructed a set of projection operators  $E(\lambda)$  with the property that  $H$  (where  $H = H^*$ ) admits a spectral resolution  $(Hf, g) = \int \lambda d(E(\lambda)f, g)$ . He derived a similar theorem for normal operators. The spectral theorem has enormous importance in applications, and von Neumann's work has been of great influence.

Partly in collaboration with Murray, von Neumann founded the theory of weakly closed, self-adjoint algebras ("rings") of bounded linear operators. They first studied "factors"—that is, rings generalizing simple algebras—and

developed a "direct sum" theory for rings of operators. The effect of von Neumann's work here is enormous. A whole school has grown up in the past decade devoted to a study of operator rings and their abstract analogs.

In pursuing his researches on rings of operators he was led to introduce the notion of a dimension function into ring theory and found thereby "geometries without points." He developed this theory into his important continuous geometry, which was the subject of his 1937 colloquium lectures to the American Mathematical Society.

The influence of von Neumann's interest in groups can be detected in all phases of his work on operators. In particular, the direct sum theory has many applications in the theory of unitary representations of non-Abelian noncompact groups, as is shown in the work of Mackey, Godement, Mautner, Segal, and Gel'fand and his school. Von Neumann's work on unbounded operators has heavily colored analysis in the past 25 years. It seems safe to predict that his work on operator rings will color it even more strongly during the next 25.

His contribution to the theory of groups did not stop here. He was the first to show that every subgroup of a matrix group is a Lie group. This result is fundamental to the present techniques for analyzing locally compact groups. He also showed that every compact group can be approximated by Lie groups, and as a consequence that every compact locally Euclidean group is a Lie group. His work on almost periodic functions on groups won for him the Bôcher prize.

His elegant proof of the ergodic theorem stands as one of his important results. Its ramifications have had a profound influence on the study of dynamical systems.

Von Neumann was one of the founders of the theory of games. In spite of the nearly 30 years that have passed since von Neumann's first paper was written on this subject, and in spite of the intensive development of the theory in these 30 years, there is very little in his first paper that would be revised today. It is, as are many of his early papers, strongly under the influence of the axiomatic thinking and gives a formal system which permits a complete description of all the intricacies of a game, with play and counterplay, chance and deception. The paper contains a rigorous definition for the concepts of pure strategy (a complete plan, formulated prior to the contest, making all necessary decisions in advance) and of mixed strategy (the use of a chance device to pick the strategy for each contest). Although similar concepts were used before (by Zermelo and by Borel),

no one had used them before with the same incisiveness as von Neumann did when he established the "minimax theorem" for zero sum two-person games. This theorem, which proved valuable for von Neumann's studies in economics, also gave the key to the analysis of games with more than two players, permitting the formation of alliances and camps between the players.

The book, *The Theory of Games and Economic Behavior*, by him and Morgenstern, has affected decisively the entire subject of operations research. Indeed, it may well be said that the present-day importance of the subject results from the influence of this monumental work.

The preceding three subjects are the ones which come to mind at once when writing about von Neumann's contributions to mathematics. However, they are surely not the only fields which have profited from his fertile imagination. He has made significant contributions literally to every branch of mathematics, with the exception of topology and number theory. His knowledge of mathematics was almost encyclopedic—again excepting the afore-mentioned two fields—and he gave help and advice on many subjects to collaborators and casual visitors, possibly to a greater extent than any other present-day mathematician.

It would be very difficult to tell which of von Neumann's contributions to theoretical physics was the more important: the direct or the indirect ones. Four of his direct contributions are known to all physicists. His recognition that vectors in Hilbert space are the proper mathematical concept to describe the states of physical systems in quantum mechanics is unique in the sense that no other person would have realized this fact for many years. Closely related to this observation is his description of quantum mechanics itself. The sketch of his ideas in this connection, presented in chapter VI of his *Mathematische Grundlagen der Quantenmechanik*, still constitutes inspiring reading. Von Neumann's third main contribution is the application of the concept of the mixture of quantum mechanical states—which he invented independently of Landau—to problems of thermodynamics and statistical mechanics. The considerations on irreversibility, in both classical and quantum physics, were his fourth major contribution.

These contributions, and some others of a more specialized nature, would have secured him a distinguished position in present-day theoretical physics quite independently of his indirect contributions.

Von Neumann developed several mathematical concepts and theorems which became important for the theoretical physicist; he probably developed them with these applications in mind. In fact, it often seems to the theoretical physicist that the best of von Neumann's mathematical work was motivated by its projected usefulness in some applied science. From the point of view of the theoretical physicist, his two most important mathematical contributions were the theory of nonbounded self-adjoint or normal operators in Hilbert space and the decomposition of representations of noncompact groups, carried out in collaboration with Mautner (both of these are described in the preceding section). Many of von Neumann's colleagues think that his late work, centered around the development of fast computing machines, was also motivated by his desire to give a helping hand to his colleagues in mathematics' sister sciences.

No appraisal of von Neumann's contributions to theoretical physics would be complete without a mention of the guidance and help which he so freely gave to his friends and acquaintances, both contemporary and younger than himself. There are well-known theoretical physicists who believe that they have learned more from von Neumann in personal conversations than from any of their colleagues. They value what they have learned from him in the way of mathematical theorems, but they value even more highly what they have learned from him in methods of thinking and ways of mathematical argument.

Von Neumann's contributions to economics were based on his theory of games and also on his model of an expanding economy. The theory of games has relevance in many fields outside of economics; it answers a desire first voiced by Leibnitz but not before fulfilled. It has been stated (by Copeland of Michigan) that his theory may be "one of the major scientific contributions of the first half of the 20th century." The theory rests on von Neumann's minimax theorem, whose significance and depth are only gradually becoming clear. The the-

ory gives a new foundation to economics and bases economic theory on much weaker, far less restrictive assumptions than was the case thus far. The current analogy between economics and mechanics has been replaced by a new one with games of strategy. Entirely new mathematical tools were invented by von Neumann to cope with the new conceptual situations found. This work has given rise to the publication by many authors of several books and several hundred articles. His study of an expanding economy is the first proof that an economic system with a uniform rate of expansion can exist and that the rate of expansion would have to equal the rate of interest. This study has deeply influenced many other scholars and will unquestionably become even more significant now that problems of growth are being so widely investigated by economists.

The principal interest of von Neumann in his later years was in the possibilities and theory of the computing machine. He contributed to the development of computing machines in three ways. First of all, he recognized the importance of computing machines for mathematics, physics, economics, and many problems of industrial and military nature. Second, he translated his realization of the significance of computing machines into active sponsorship of a computer—called JOHNIAC by his affectionate collaborators—which served as a model for several of the most important computers in the United States. Third, he was one of the authors of a series of papers which gave a theory of the logical organization and functioning of a computer which reminds one of the axiomatic formulation of mathematics, a subject to which he devoted so much of his early youth. In these papers is also formulated a quite complete theory of coding and programming for machines. Here is the complete notion of flow-diagrams and the genesis of all modern programming techniques. In one of these papers is given the criteria and desiderata for modern electronic computing machines.

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## News of Science

### Jaw of Gigantopithecus

John Hillaby, an English science writer, has reported the discovery of a fossil lower jaw attributed to *Gigantopithecus blacki* [*New York Times*, 17 Mar. 1957]. If this mandible is actually that of *Gigantopithecus*, it will contribute greatly to the resolution of one of the current enigmas of paleoanthropology.

*Gigantopithecus* is a genus of extinct primate based on three fossil molar teeth (one upper, two lower) found by the Dutch paleontologist, G. H. R. von Koenigswald, in native drugstores of Hong Kong between 1934 and 1939. These teeth are truly colossal, greatly exceeding all known human and anthropoid ape teeth in their dimensions. Even those of an adult male gorilla are dwarfed by comparison. Von Koenigswald [*Proc. Kon. Akad. Wet. Amsterdam*, Sec. Sc., 38, 872, 1935] regarded the holotype tooth as that of a giant ape—hence the name *Gigantopithecus*. Discovery of the two other teeth strengthened this opinion. The late Franz Weidenreich [*Anthrop. Papers Am. Mus. Nat. Hist.*, 40, pt. 1, 1, 1945], however, thought that the teeth were human, rather than simian; moreover, he made *Gigantopithecus* a keystone of his tenuous hypothesis that the ancestors of man were giants.

The primate nature—indeed, the catarrhine primate nature—of these isolated teeth seems clear. Yet, since they represent such slender evidence for the precise taxonomic allocation of *Gigantopithecus*, it has seemed logical, to some people, at least, to label this genus *incerta sedis*. Notwithstanding, considerable futile argument respecting its status has continued. For some, it is an anthropoid ape; for others, a man; for still others, an Asiatic representative of the Australopithecinae, that group of so-called "man-apes" from the early Pleistocene of South Africa. From the faunal relations in which they were apparently found, the *Gigantopithecus* molars have been dated, at earliest, Middle Pleistocene.

The new jaw, attributed to *Gigantopithecus*, was recently found in a high cliff cave in Kwangsi province, South China, by a peasant. W. C. Pei, a pale-

ontologist who played a major role in the discovery of the remains of Peking man (*Sinanthropus pekinensis*), gives the geological age of the new find as Middle Pleistocene; this would make the giant a contemporary of Peking man. Moreover, Pei regards the animal as a giant ape, hence agreeing with the original diagnosis of von Koenigswald. He believes, however, that it was more manlike than any other ape, living or extinct.

Pei also sent Hillaby an excellent photograph of the new jaw, which is reproduced in the *New York Times* article. This photograph, taken from above, suggests that the mandible is quite complete rostrally, and backwards so as to include the second molar teeth. The remainder of the mandible—third molars, both rami, hence, unfortunately, the coronoid processes and condyles—is lacking. The occlusal surfaces of the teeth appear to have been worn down considerably, so that the crown patterns of the molars cannot be made out. In the general shape and proportions of their crowns, however, these teeth distinctly resemble the two type lower molars of *Gigantopithecus*. Thus, at least on dental grounds, the allocation of this new mandible to that genus seems justified. We have, as yet, however, no information about its actual size.

From the photograph, at any rate, one can concur with Pei's diagnosis of the jaw as that of an ape (but whether it is actually more manlike than the lower jaws of other apes, living or extinct, remains to be determined). Thus, the canines are massive, as in apes (they are small in men, both fossil and extant). The first premolar tooth, in contrast to the second, appears clearly to be narrow and compressed, hence sectorial, as in the anthropoid apes (rather than essentially rectangular and molariform, as in hominids); this in turn suggests a large maxillary canine tooth. As in the type specimens, the molars are distinctly longer than broad, this being another simian character. The second molar tooth is larger than the first molar, as in anthropoid apes (the reverse being the rule for men). There obviously is a large simian shelf of bone jutting backward from the lower symphyseal region between the two halves of the body of the

mandible, as in the great apes; from which one is led to infer, with reasonable certainty, that there is no chin.

The body of the jaw itself seems to be unusually thick in relation to tooth size (but it is entirely possible that this impression may be a photographic illusion), although not as thick relatively as that of *Meganthropus palaeojavanicus*. The incisor teeth, of which the left medial one is lacking, appear to be relatively small, even peglike rather than chisel-like. The space between the canine teeth is therefore comparatively narrow; consequently, instead of the tooth rows being parallel, as in existing anthropoid apes, they are slightly incurved rostrally to approximate a Gothic arch. In this, the new mandible somewhat recalls the Australopithecines, which are characterized by remarkably small incisor teeth. Nevertheless, these particular teeth of the Chinese fossil are not so markedly reduced as are those of the South African man-apes; and the presence of large canines, sectorial first premolars, and prominent simian shelf offers scant comfort for those who, like the late Robert Broom, have identified the original, isolated teeth as those of an Asiatic Australopithecine.

The mandible does not represent the entire animal; nor, indeed, can it foretell the entire skull. Yet, despite these limitations, this new lower jaw, if it truly is that of a *Gigantopithecus*, seems to make it clear that this "Hong Kong drugstore giant," as the late Earnest Hooton dubbed him, was neither an ancestral giant hominid nor an Australopithecine, whatever precisely he may have been.

WILLIAM L. STRAUS, JR.  
*Johns Hopkins University*

### Indian Ocean Expedition

Yale University's Bingham Oceanographic Laboratory will send the first major deep-sea scientific expedition into the Indian Ocean area around the Seychelles Islands next summer. No marine-biological expedition has ever concentrated its efforts in the Seychelles area, so that no major scientific collection of marine specimens from the area exists. James E. Morrow, Jr., research associate at the Bingham Laboratory, will lead the group, which will include Willard D. Hartman, assistant professor of zoology and associate curator of invertebrate zoology, and Alan J. Kohn, graduate student in zoology. Technical adviser for the trip will be Alfred C. Glassell, Jr., of Houston, Tex.

The expedition will use two vessels, a 110-foot mother ship in which a complete oceanographic laboratory will be installed and in which supplies will be



kept, and a 40-foot vessel for collecting specimens and doing hydrographic work. The 110-foot vessel is necessary because of the inaccessibility of the Seychelles.

The expedition will start on about 1 Aug. from Colombo, Ceylon, and will make exploratory stops at the Maldive and Chagos Islands before reaching the Seychelles. In December the party will proceed to Mombasa, Africa, where it will officially disband.

However, all three of the scientists are planning much more extensive research and exploratory trips than just during the course of the actual expedition. Tomorrow, for example, will leave Yale in June to collect specimens and do research in Japan and Formosa. After reaching Mombasa he will go to Beira and Durban in Southeast Africa, and possibly to Mauritius Island for further work, and will then visit museums in Europe and London before returning to Yale in February 1958. Hartman and Kohn will visit several spots in the Orient before joining the expedition in Ceylon in August.

Tomorrow, during the Seychelles exploration, will concentrate on the so-called "bill" fishes, mainly the marlin family, to further studies he has been engaged in for the last decade. The group will also make shore and reef studies and collect specimens in these categories as well as doing open-sea collecting. Hartman will concentrate on collecting sponges, and Kohn will devote most of his attention to the mollusk family. Specimens will be collected not only for Yale's laboratory but for the Natural History Museum of Stanford University.

### Donner Provides X-rays

The Donner Foundation of Philadelphia has announced that it has ordered 12 2-million-volt x-ray generators for the treatment of deep-seated cancers at medical-radiological centers across the country. The machines, which cost \$833,000, will be installed before the end of the year at the Los Angeles (Calif.) Tumor Institute; the Johns Hopkins Hospital of Baltimore; the Charity Hospital of Louisiana at New Orleans; the department of radiology of the University of Pennsylvania Hospital; the Temple University Hospital; the University of Oregon at Portland; the division of radiotherapy and isotopes of the Mary Fletcher Hospital at Burlington, Vt.; the Tom B. Bond Radiological Group of Fort Worth, Tex.; the department of radiotherapy of the St. Joseph Infirmary at Louisville, Ky.; the University of Missouri School of Medicine at Columbia; the University Hospital at Oklahoma City, and the Grace-New Haven Community Hospital at New Haven, Conn.

### New Hormone

A research team at the University of Chicago has reported that it has established the mechanism and site of production of a new hormone that controls red blood cell formation. The hormone, erythropoietin, is produced in response to the changing balance between the oxygen demand and supply of the body. The process is analogous to the mechanism by which the level of blood sugar regulates the production of insulin.

Erythropoietin is produced by the kidneys and is found in normal blood of human beings and animals. It stimulates the bone marrow to make the red cells. Though it has not yet been chemically isolated, it has been concentrated in blood serum by 100 to 1000 times its normal amount. Leon O. Jacobson, professor of medicine, and three members of his research group, Eugene Goldwasser, assistant professor of biochemistry, and Walter Fried and Louis F. Plzak, Jr., medical students, reported the investigation results in the 23 Mar. issue of *Nature*.

### Acquisition of Site for NSF Observatory

The National Science Foundation has announced that the Corps of Engineers, U.S. Army, has undertaken acquisition of the site for the foundation-supported radio astronomy observatory at Green Bank, W.Va. The Engineers, acting on NSF's behalf, have established a field office for this purpose at Marlinton, W.Va. The new research center for radio astronomy will be constructed and operated for the use of the nation's scientists by Associated Universities, Inc., under contract to the foundation.

Land to be purchased will encompass approximately 2100 acres bounded on the south by Green Bank, on the east by Route 28, on the west by U.S. Forest Service lands, and on the north by a line running east to west approximately 2 miles north of Green Bank. In order that the observatory may be protected to the maximum extent possible from man-made radio noise or interference, restrictive easements will be acquired, as necessary, on approximately 10,000 acres of the privately owned lands adjoining the site. It is not anticipated that these easements will interfere with the normal activities or purposes for which these lands are currently being used.

Green Bank is in Pocahontas County, in the mountains of southeastern West Virginia, about 35 miles south of Elkins. As was announced earlier by the foundation, it was selected over 29 other sites after an intensive review covering a wide area of the country. The Green Bank site fulfills most requirements for

an ideal site for a radio telescope—requirements which are extremely stringent in terms of the need for an absolute minimum of radio noise or interference on wavelengths below 10 meters.

### Ford Foundation Annual Report

Approximately \$2 of every \$3 spent by the Ford Foundation in the last fiscal year have directly benefited education in the United States. The foundation's 1956 annual report shows that \$401 million of a total commitment of \$602 million was designated for support of basic institutions and activities in education during the fiscal year ended 30 Sept. The \$401 million figure—representing \$312 million in grants and \$89 million reserved for future grants—includes the sum of \$210 million to help improve college faculty salaries.

Other major educational commitments made by the foundation during the year included: medical education, \$100 million; the Fund for Adult Education, \$17.5 million; educational television, \$8 million; development of library resources, \$5 million; nonsalary teacher benefits, \$5 million; and publication in the humanities and social sciences, \$1,725,000.

Of the \$400 million total, \$50,479,000 in grants came from appropriations carried over from previous years, including a \$50-million appropriation that was converted into "accomplishment grants" for institutions which had led the way previously in bolstering faculty salaries. Other appropriations and grants for American education totaled nearly \$3,411,000.

### NBS Solar Furnace

A solar furnace that generates temperatures up to 3500°C was demonstrated recently at the National Bureau of Standards to winners of the 16th Westinghouse Science Talent Search. This first public announcement of the new NBS facility coincided with the annual Washington visit of these young people.

When the furnace mirror is turned to pick up the sun's rays, a test specimen of high-temperature resistant material will shatter into pieces as its temperature soars almost instantaneously to 3500°C. Research people at NBS are now using the solar furnace to melt refractory materials in a controlled environment free of contaminating agents. Such furnaces are being employed in an intensive search at the bureau and at other scientific laboratories throughout the nation to find materials that will withstand the extreme temperature conditions found in atomic reactors, jet aircraft engines, and guided missiles.

## NSF Earth Science Awards

The Earth Sciences Program of the National Science Foundation is now receiving proposals for research grants that will be made in October and November, 1957. Deadline for the Receipt of proposals for work to begin in the fall or early winter is 20 May. There are no formal application blanks, but a foundation pamphlet describes the method of making application and outlines information needed in a proposal. This pamphlet may be obtained from the Earth Sciences Program, National Science Foundation, Washington 25, D.C.

## Brussels Computation Center

An analog computation center will be opened in Brussels, Belgium, during the early summer of 1957 by Electronic Associates, Inc., of Long Branch, N.J. The center will provide electronic analog computers and a staff of scientists for problem analysis and programming.

## Indian Engineers to Come to U.S.

Recently Ellsworth Bunker, United States Ambassador to India, announced a new program under which 900 to 1000 Indian engineers will be sent to the United States in the next 5 years to receive from 1 to 2 years of training in iron and steel technology. An agreement has been reached between the Government of India, the Ford Foundation, and representatives of the United States iron and steel industry. The Indian Government will pay the transportation costs, and the United States steel industry will provide training opportunities. The Ford Foundation will meet the students' maintenance. It has set aside about \$1 million for the first year of the project.

## World Directory of Crystallographers

The International Union of Crystallography is preparing a World Directory of Crystallographers that will contain the names and addresses of all practicing crystallographers, including advanced graduate students. It is hoped that a preliminary list can be compiled by the time of the Fourth General Assembly to be held in Montreal, 10-17 July. The secretaries of the national committees (*Acta Cryst.*, 8, 857; 1955) have been asked to prepare a list of crystallographers in their countries.

Some scientists and technologists, however, who carry on crystallographic work (including x-ray, electron, or neutron diffraction and microscopy or other techniques) are not members of scien-

tific societies having a unique crystallographic interest, and might therefore be missed. Those who come into this category are asked to send their names and addresses to Dr. W. Parrish, Philips Laboratories, Irvington-on-Hudson, N.Y.

## AEC Classified Depository Library in New York

The U.S. Atomic Energy Commission has announced that a classified depository library has been established at its New York Operations Office to serve the needs of access permittees and commission contractors in the area. The library is the first of a number of such depositories planned for various regions of the country as part of the commission's program to facilitate access by cleared personnel to classified technical information.

Persons wishing to use the library facilities must apply in advance of their visit. In the case of access permittees, this is accomplished by forwarding a copy of form AEC-403 to the office administering the permit. Contractors are required to file form AEC-277. Library users must observe the security requirements of part 95, title 10, "Safeguarding of restricted data," published in the *Federal Register* on 2 Feb. 1956.

The documents in the library are for reference purposes only. Information on the price and source of individual reports will be available, however. Library users may request classified literature only in categories to which they have been granted access. Library personnel will not perform literature searches, but bibliographic material, such as abstracts and indexes, will be available so that a library user can determine the exact number of the report he wishes to see and request it by that number.

The opening of the classified library at the New York Operations Office brings to four the number of AEC depositories of technical literature in the New York area. Libraries of unclassified documents were established at the Columbia University Library and the New York Public Library in 1951, and at the Office of the Atomic Industrial Forum in 1954.

## Elementary School Workshop

A summer Workshop in Science for Teachers in Elementary Schools is scheduled from 17 June through 26 July at Western Reserve University. Open to graduate students of education, six credit hours may be earned toward an advanced degree during the session. Principles in astronomy, biology, chemistry, geology, and physics will be emphasized. Methods of demonstration and

experiment applicable to the elementary school will be stressed.

Director of the workshop will be James C. Gray, professor and acting chairman of the biology department. Grace C. Maddux, assistant supervisor of science for the Cleveland Board of Education, is associate director. Full time members of the W.R.U. faculty and experienced teachers in the Cleveland Public School System will serve on the staff.

Classes will be held at the university's Biological Station at Squire Valleevue Farm in suburban Hunting Valley, about a 20-minute trip from the campus. Application for enrollment should be made by 1 May. A limited number of scholarships are available. For further information, write to Director of Admission, Western Reserve University, 2040 Adelbert Road, Cleveland 6, Ohio.

## Topography of Greenland

A French expedition is planning a long-range exploration of Greenland in 1957-58, according to a report from the United Nations Educational, Scientific and Cultural Organization. Led by explorer Paul-Emile Victor, a group of scientists will attempt to discover whether Greenland, beneath its ice-cap, is one vast island or a number of smaller islands. Soundings through the ice will be made to help determine the general topography of the land.

## NSF Awards

The National Science Foundation has announced the award of 845 predoctoral graduate fellowships in the natural sciences and allied fields of the academic year 1957-58. Successful fellows were selected from 3028 applicants from all parts of the continental United States, Alaska, Hawaii, and Puerto Rico. Honorable mention was accorded 1391 applicants.

In addition to the predoctoral fellowships awarded, the foundation also announced the names of 84 winners of regular postdoctoral fellowships. (Regular postdoctoral fellowships are to be distinguished from senior postdoctoral and science-faculty fellowships, awards for which will be announced later.)

Of the predoctoral fellowships, 245 awards were made to first-year graduate students, 376 awards were made to graduate students in the intermediate years, and 224 awards to terminal-year predoctoral students. Recipients include 426 persons who have been NSF fellows during the current academic year.

The largest group of predoctoral fellowships, 185 were awarded in chemistry. In other fields the number of awards



were: physics 183, engineering sciences 114, mathematical sciences 86, zoology 64, earth sciences 41, biochemistry 33, psychology 25, medical sciences 20, botany 16, microbiology 16, genetics 13, anthropology 12, agriculture 9, astronomy 6, biophysics 6, general biology 2. In addition 14 awards were made in areas where the natural sciences converge with the social sciences.

Of the regular postdoctoral awards, 33 were made in the life sciences, 17 in chemistry, 15 in physics and astronomy, 13 in the mathematical sciences, 3 in the earth sciences, 2 in the engineering sciences, and 1 in areas where the natural sciences converge with the social sciences.

Fellows may attend any accredited nonprofit educational institution of higher learning in the United States or abroad. Predoctoral fellowships carry stipends of \$1600 for the first year, \$1800 for intermediate years, and \$2000 for the terminal year of graduate study. Regular postdoctoral fellowships carry a stipend of \$3800. All fellowships include additional allowances for dependents, tuition, and other normal expenses.

The foundation has also announced that 345 grants totaling \$13,853,350 were awarded during the quarter ending 31 Dec. 1956 for the support of basic research in the sciences, for conferences in support of science, for exchange of scientific information, and for training of science teachers. This is the second group of awards to be made during fiscal year 1957. Since the beginning of the program in 1951, 3166 such awards have been made totaling almost \$49,900,000.

### AEC Aids Nuclear Technology Training

The Atomic Energy Commission has announced approval of grants totaling \$1,193,450 to 15 American educational institutions for equipping laboratories for training nuclear scientists and engineers. The commission also has made 16 loans to universities and colleges of material such as uranium metal and neutron sources.

More than 40 proposals for grants in this category have been received by the AEC since last September. All proposals will be reviewed and evaluated, and additional announcements of awards are planned for the near future. The largest grant—\$216,950 to the University of Puerto Rico—is for the establishment there of a nuclear training center. Copies of the criteria used in evaluating institutional proposals for AEC assistance may be obtained from the Director, Division of Reactor Development, Atomic Energy Commission, Washington 25, D.C.

### Norelco Diffraction School

The 27th Norelco X-ray Diffraction School for research and industrial registrants who can visit the Midwest will be held in the Morrison Hotel, Chicago, Ill., during the week of 3-7 June. Registration for the course will be limited to 125 for the first 4 days and to 150 on Friday, the day devoted to actual application problems when guest speakers deal with current methods used by modern plants.

Until the final day, the sessions will consist of classroom and laboratory work during which participants discuss their problems and become familiar with the use of all equipment types. The basic subjects to be covered by well-known educators and scientists include x-ray diffraction, diffractometry, and spectrography. There will also be discussions of new high- and low-temperature camera techniques, electron microscopy, and electron diffraction.

Application for attendance at the three Norelco Diffraction Schools held last year far outnumbered the available accommodations. It is recommended that those planning to attend the coming June meetings make their reservations at the earliest possible date. There is no registration fee. For information, write to Philips Electronics, Inc., 750 South Fulton Ave., Mount Vernon, N.Y.

### Gypsy Moth Eradication

The U.S. Department of Agriculture has announced plans for a federal-state cooperative spray program this spring to eradicate the gypsy moth from almost 3 million acres of forest land in parts of New York, New Jersey, and Pennsylvania. Spraying against this destructive forest pest from the air with DDT is scheduled to begin on about 15 Apr. and will continue to mid-June. The insecticide will be applied at the rate of 1 pound in 1 gallon of light oil to each acre treated. In area, this will be the largest single aerial spraying job ever conducted in the United States.

About \$5 million have been appropriated by state governments and the Federal Government for gypsy-moth control and eradication programs in the nine northeastern states during the current season. More than half of this amount will be used in the federal-state spray program along the southern and western periphery of the area generally infested with gypsy moth. In addition, state control operations will continue in other infested portions of the nine states.

The combined program calls for eventual complete eradication of the gypsy moth. By defoliating trees, the gypsy moth caterpillar destroys millions of

board feet of valuable timber and does great damage to forest and shade trees in recreation areas, on watersheds, and around homes. If left uncontrolled, the pest would threaten hardwood forests from Maine to the Ozark Mountains in the south-central United States.

### Chinese Birth Control Measures

The Associated Press has reported that the People's Republic of China has announced that it is starting a large-scale birth-control program. In addition, physicians are now permitted to perform abortions and sterilization operations when patients request them. The new program was described by the Minister of Health, Li Teh Chuan, in a speech to the National Committee of the Chinese People's Political Consultative Conference that was broadcast by the Peking radio. China's population is estimated at more than 600 million; it is increasing by about 15 million persons a year.

### Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills introduced recently follows:

S 872. Provide school-construction assistance to states; establish a program of scholarship aid and long-term loans to students in higher education; provide facilities assistance to institutions of higher education; provide a 30-percent credit against Federal individual income tax for amounts paid as tuition or fees to certain public and private institutions of higher education; provide assistance to and cooperation with states in strengthening and improving state and local programs for diminution, control, and treatment of juvenile delinquency; study use of conservation programs to provide healthful outdoor training for young men; establish a Youth Conservation Corps. Humphrey (D Minn.) Senate Labor and Public Welfare.

S 844. Provide program of national health insurance. Murray (D Mont.) Senate Labor and Public Welfare.

HR 3865. Provide for further research and technical assistance required for control of mosquitoes and other arthropods capable of adversely affecting the health and welfare of man. Rogers (D Fla.) House Interstate and Foreign Commerce.

H Res 130. Authorize creation of a Select Committee on Problems of Aging. Powell (D N.Y.) House Rules.

HR 3764. Provide program of national health insurance. Dingell (D Mich.) House Interstate and Foreign Commerce.

S 845. Authorize Secretary of Army, Secretary of Navy, and Secretary of Air Force to make grants to certain educational institutions for construction of military and naval science buildings. Murray (D Mont.), Mansfield (D Mont.) Senate Armed Services.

H J Res 186. Provide for observance and commemoration of the 50th anniversary of the official founding and launching of the conservation movement for protection in public interest of the natural resources of the U.S. Dingell (D Mich.) House Judiciary.

HR 3631. Provide for an experimental research program in cloud modification. Hull (D Mo.) House Interstate and Foreign Commerce.

HR 3639. Relating to certain inspections and investigations in metallic and non-metallic mines and quarries (excluding coal and lignite mines) for purpose of obtaining information re health and safety conditions, accidents, and occupational diseases therein. Metcalf (D Mont.) House Education and Labor.

S 868. Provide a 30-percent credit against Federal individual income tax for amounts paid as tuition or fees to certain public and private institutions of higher education. Humphrey (D Minn.) Senate Finance.

## Scientists in the News

J. ROBERT OPPENHEIMER, director of the Institute for Advanced Study at Princeton, N.J., has been selected to deliver the William James lectures at Harvard University during April and May. The eight lectures on "The hope of order," which are being given under the joint auspices of the department of philosophy and psychology, will analyze the unprecedented nature of our times compared with the high cultures of the past in the rapid increase of knowledge, the multiplicity of human communities, and the increasing difficulty of communication. Oppenheimer will discuss how science has contributed to this state of affairs through the rapidity of its advance, the radical and varied nature of its means of acquiring new knowledge, and through its application to technology and a new economy.

ELMER HUTCHISSON, dean of the graduate school and director of the research division of the Case Institute of Technology, has been named director of the American Institute of Physics. He succeeds HENRY A. BARTON, who has been director of the AIP since its formation in 1931, and who will continue to be associated with the institute on a part-time basis with the title of associate director. The change will take place on 1 July.

STUART PATTON, associate professor of dairy science at Pennsylvania State University, received the \$1000 Borden award in the chemistry of milk at Miami, Fla., on 8 Apr. during the 131st national meeting of the American Chemical Society. Patton has done outstanding work in dairy chemistry, especially on the identification and method of formation of objectionably flavored compounds in dairy products. His diversified research includes studies of heat-induced flavors in milk, the manufacture of butter-oil, and the color changes in evaporated milk. Others who were presented with awards at the same time included the following:

PETER J. W. DEBYE, emeritus professor of chemistry, Cornell University, received the \$1000 Kendall Company award in colloid chemistry. Debye, who earned the Nobel prize in 1936 for his contributions to knowledge of the structure of molecules, was honored for his continuously active research. The light-scattering techniques that he devised have proved their worth in the study of polymers and are now finding extended use in colloid chemistry. Debye's recent work has included studies of polymer solutions and of solutions of soap and silicates.

G. ROBERT GREENBERG, associate professor of biochemistry at Western Reserve University's School of Medicine, received the \$1000 Paul-Lewis Laboratories award in enzyme chemistry for his contributions to the understanding of how purines—components of nucleic acids—are formed. Greenberg's investigations of purines have led to new concepts in body chemistry.

RALPH MÜLLER, staff member in charge of special instrumentation problems at the Los Alamos Scientific Laboratory of the University of California, received the \$1000 Beckman award in chemical instrumentation. Müller is credited with playing a major role for the past 15 years in the growth of instrumentation as a distinct branch of science. His pioneering studies on instruments to analyze compounds by specific measurement of such properties as light intensity, radiant energy, and color have resulted in the development of automatic devices that have proved valuable to chemists. He is coauthor of one of the first books on electronics written especially for the chemist, and since 1946 has been describing progress in analytical instrumentation in a monthly column that appears in *Analytical Chemistry*.

CLARENCE B. LINDQUIST, head of the department of mathematics and engineering at the University of Minnesota, Duluth, has been appointed chief for natural science and mathematics in the Division of Higher Education of the U.S. Office of Education.

JAMES C. LANDES, who recently completed 3 years as a project engineer in the industrial waste department of Inflico, Inc., Tucson, Ariz., has accepted a position as bacteriologist in Eli Lilly Company's biological development department.

ARTHUR W. WESTON, former assistant director of development at Abbott Laboratories, Chicago, Ill., has been appointed as the laboratory's director of research. He succeeds ROBERT D. COGHILL, who has resigned but who will continue until April to serve as a consultant.

DARYL M. CHAPIN, CALVIN S. FULLER, and GERALD L. PEARSON, all members of the technical staff of the Bell Telephone Laboratories, have received John Scott medals for their development of the Bell solar battery. The medals were accompanied by a premium of \$2000 that was divided equally among the three recipients.

The Scott medal is named for John Scott, a chemist of Edinburgh, Scotland, whose will in 1816 established the award and entrusted its administration to the City of Philadelphia. He instructed that it be given to "ingenious men and women who make useful inventions." Originally the premium accompanying the medal was \$20, but over the years the legacy of \$4000 has grown to approximately \$110,000, and the premium has been increased.

GEORGE SASLOW, who is at present clinical professor of psychiatry at Harvard University Medical School and chief of psychiatry, Massachusetts General Hospital, Boston, has been named to head the University of Oregon Medical School's department of psychiatry. He succeeds HENRY H. DIXON, who will continue on the staff as clinical professor of psychiatry.

A second appointment at Oregon is that of JOSEPH D. MATARAZZO as professor of medical psychology. Matarazzo is associate psychologist at Massachusetts General Hospital and research associate at the Harvard Medical School. Both appointments become effective on 1 June.

Two new departments have been created in Eli Lilly and Company's pharmacological division. Named to head the pharmacodynamics department is FRANCIS G. HENDERSON; IRWIN H. SLATER has been promoted to head of the neuropharmacology department. Neuropharmacology deals with all drugs that act on the nervous system. The pharmacodynamics department is concerned with drug action on systems of the body other than the nervous system.

NATHAN MARCUVITZ, professor of electrical engineering at the Polytechnic Institute of Brooklyn, has been appointed director of Polytechnic's Microwave Research Institute. HERBERT J. CARLIN, a research professor, has been named associate director.

E. M. JELLINEK, specialist in alcoholism, has arrived in this country from Switzerland to lay the foundation for a 2-year world-wide survey of the progress being made in the control of alcoholism. The survey will be conducted under the auspices of the Christopher D. Smithers Foundation, New York, which will publish the findings of the completed survey in monograph form.

Jellinek is a pioneer in the movement to control alcoholism. For a period of 7 years, until his retirement in 1956, he was consultant on alcoholism to the World Health Organization. He is now secretary general of the International Institute for Research in Problems of Alcohol with headquarters in Geneva, Switzerland.

In the United States, where much of his first work was carried out, Jellinek is regarded as the father of the movement against alcoholism as a disease. Among his most significant achievements in the United States are his founding of the first two clinics for the diagnosis and treatment of alcoholics in Hartford and New Haven, Conn.

FREDERICK C. STEWARD, professor of botany at Cornell University since 1950, has been named a fellow of the Royal Society, England. Each year the society elects a maximum of 25 fellows from all branches of science, as well as certain foreign fellows. Steward, born and educated in England, will be a fellow rather than a foreign fellow.

Steward works in the physiology of plant nutrition, metabolism, and growth. He was perhaps the first to investigate the mechanism of salt absorption by plants; and recently, with his associates, he has been responsible for detecting, isolating, and identifying a number of soluble nitrogen compounds in common plants. Among these are gamma-aminobutyric acid in the Irish potato, pipercolic acid in green beans, and new amino acids in such plants as dates and tulips. New chromatographic techniques have made this work possible.

IRVING H. SHAMES, formerly of the University of Maryland and Stevens Institute of Technology, has been named head of the newly formed department of engineering science of the Pratt Institute Engineering School. This new department will teach a considerable portion of the basic engineering science for all other departments.

WOLFGANG KOHLER, internationally known psychologist, is spending the spring term at Michigan State University as this year's distinguished visiting professor. Kohler is one of the three founders of Gestalt psychology, which not only altered much thinking in psychology but stimulated much new research in related fields as well. Kohler, who was born in Reval, Estonia, had an illustrious career in Europe before joining the faculty of Swarthmore College in 1935. During 1955-56 he was on leave at the Institute for Advanced Study, Princeton.

ARTHUR CRONQUIST, an associate curator of the New York Botanical Garden, has been appointed curator. RICHARD M. KLEIN, also an associate curator of the garden, has been named Alfred H. Caspary curator. This latter post has been endowed by a grant from the estate of Alfred H. Caspary. The incumbent will devote himself to investigations of the relation of plants to the health and well-being of man and to coordination of the work of the Botanical Garden in this area with that of the Rockefeller Institute for Medical Research.

FRITZ KLEIN of the Weizmann Institute of Science at Rehovot, Israel, will be the guest speaker on 7 May at the scientists' United Jewish Appeal annual campaign meeting that will take place at U.J.A. headquarters in New York. Klein, who is at present working at the Brookhaven National Laboratories, will discuss "The future of atomic energy in Israel."

HIDEKI YUKAWA, Nobel prize winner, resigned as a member of the Japanese Atomic Energy Commission on 18 Mar. on the ground of illness.

SERGE A. KORFF, professor of physics at New York University and a specialist in cosmic rays, has received the French Government's Order of Merit for Research and Invention.

CLAUDE E. FORKNER, R. TOWNLEY PATON, LELAND R. ROBINSON, and ALLEN O. WHIPPLE, all New York physicians, recently received the Royal Order of Homayun from Iranian Ambassador Ali Amini in recognition of their service in the foundation and operation of Nemazee Hospital at Shiraz, capital of Fars Province in southern Iran, and in development of the Shiraz public water system. The four doctors have long been associated with Iran and all are members of the board of the Iran Foundation, Inc., which administers Nemazee Hospital and other health and education activities in Iran.

JAMES H. KETTERING, chemist at the Naval Research Laboratory, Washington, D.C., for 39 years, was presented with a letter of appreciation by the director of the laboratory when he retired on 31 Mar.

JEROME C. HUNSAKER, member and former chairman of the National Advisory Committee for Aeronautics, has received the Distinguished Service Medal, the committee's highest award. Hunsaker, who was a member of the committee in 1922-23 and who has been a member since 1938, was chairman from 1941 until last October, when he declined renomination and was succeeded by JAMES H. DOOLITTLE. The NACA cited Hunsaker for "service of fundamental significance to aeronautical science, climaxed by an outstanding and unparalleled record of leadership during the past 15 years. . ."

### Recent Deaths.

CARL E. F. GUTERMAN, Ithaca, N.Y.; 53; director of research at the State College of Agriculture and Home Economics at Cornell University and director of the Cornell agricultural experiment station; 27 Mar.

ELWELL F. KIMBALL, Glen Rock, N.J.; 84; dean emeritus of Fairleigh Dickinson University; 27 Mar.

CLARENCE D. KING, Pittsburgh, Pa.; 64; metallurgical engineer and assistant to the executive vice president of the United States Steel Corporation; 24 Mar.

JAMES LAMBERT, Ormond Beach, Fla.; 74; former superintendent of the Botanical Gardens and the Morris Arboretum of the University of Pennsylvania; 27 Mar.

WILLIS I. MILHAM, Williamstown, Mass.; 83; Field memorial professor of astronomy emeritus, Williams College; 23 Mar.

CHARLES H. PHIFER, Chicago, Ill.; 77; professor of surgery at the University of Illinois; 27 Mar.

WINTHROP M. RICE, Stamford, Conn.; 79; engineer, president of Gielow, Inc., naval architects and marine engineers; 26 Mar.

ROY J. RINEHART, Kansas City, Mo.; 76; dean of the School of Dentistry at the University of Kansas City; 22 Mar.

ROYAL L. SHUMAN, Caldwell, N.J.; 77; chemical engineer; 27 Mar.

JOSEPH R. SLEVIN, San Francisco, Calif.; 76; curator of the department of herpetology at the California Academy of Sciences; 15 Feb.

HENRY R. WAGNER, San Marino, Calif.; 94; mining engineer and historian; 28 Mar.



## Reports

### Reductive Cleavage of Disulfide Bridges in Ribonuclease

Total cleavage of the four disulfide bridges in ribonuclease (RNase) may be achieved with complete loss of enzyme activity, as assayed (1) with ribonucleic acid as substrate. Bovine pancreatic ribonuclease (Armour) (12 mg/ml) was reacted with thioglycolic acid [400 moles per mole of enzyme, assuming 13,683 as the molecular weight of ribonuclease (2) and a water content of 9.38 percent in the air-dried preparation] in 8M urea at pH 8.5 (adjusted with aqueous trimethylamine) for 4.5 hours at room temperature. The reduced ribonuclease was precipitated with acetone and 1M hydrochloric acid (39/1) at  $-5^{\circ}\text{C}$ , and the sample was washed three times with this solvent and twice with cold ether. The material so obtained was completely reduced, as indicated by the presence of eight sulfhydryl groups per mole of enzyme on spectrophotometric titration with *p*-chloromercuribenzoate (3).

An alternative method that was used for following the extent of reduction involved selective carboxymethylation of the sulfhydryl groups of reduced ribonuclease (14 mg/ml) by reaction, under nitrogen, with iodoacetic acid (700 moles per mole of protein) for 2 hours at room temperature in an autotitrator. Trimethylamine (5 percent aqueous solution) was added continuously to maintain the pH at 8.5. The reaction was stopped, and the carboxymethylated protein was precipitated and washed as described for the reduced material. (The carboxymethylated protein was used as a test for the completeness of this washing procedure by its treatment with thioglycollate as in the reduction procedure, with subsequent washing as

described. Titration with *p*-chloromercuribenzoate of the protein so treated revealed no sulfhydryl groups, thus establishing the complete removal of thioglycollate from the reduced enzyme by the washing procedure.) The product was hydrolyzed for 16 to 18 hours in 6N hydrochloric acid at  $100^{\circ}\text{C}$ . S-Carboxymethylcysteine is known to be stable under these conditions of hydrolysis (4). The hydrolyzate was dinitrophenylated (5) and chromatographed in two dimensions. A mixture of toluene, pyridine, chloroethanol, and 0.8N ammonium hydroxide (10/3/6/6) was used in the first dimension (5, 6), and, in the second, tertiary amyl alcohol and 0.2M phthalate buffer at pH 5 (2/1) (7). The component which moved identically with an authentic sample of dinitrophenyl-S-carboxymethylcysteine was eluted, and its concentration was determined spectrophotometrically (5). The chromatographic analysis revealed 8 moles of dinitrophenyl-S-carboxymethylcysteine per mole of reduced, carboxymethylated ribonuclease, but no trace of bis-dinitrophenylcystine. This method of analysis thus confirmed the completeness of cleavage of disulfide bridges as determined by titration with *p*-chloromercuribenzoate.

Carrying out the reductions in 8M urea for shorter periods of time, with a smaller excess of thioglycollate, or at slightly lower pH values, yielded partially reduced materials with varying degrees of activity (see Fig. 1).

In the absence of urea, but with other conditions identical with those described for the reduction of ribonuclease, complete cleavage of disulfide bridges in the enzyme was not achieved. This finding parallels that of Lindley (8), who demonstrated that only one of the three disulfide bridges in insulin was reductively cleaved by thioglycolic acid in the absence of urea. In the present experiments, production of sulfhydryl groups was linear up to 30 minutes, reaching a value of 3.7. After 2 hours, 4.6 sulfhydryl groups were formed. It appears that two of the disulfide bridges in ribonuclease may be opened with relative ease, but that the remaining two are cleaved appreciably only in the presence of urea. In contrast to the results experienced

with complete reduction, enzyme activity was diminished but not entirely lost during partial reduction. A correlation between the number of sulfhydryl groups per mole and enzyme activity is given in Fig. 1, which summarizes all reduction experiments performed. Carboxymethylation of the partially reduced material caused no further reduction in enzyme activity, nor did the conditions of carboxymethylation affect the activity of native ribonuclease.

When completely reduced and fully inactive enzyme (1 mg/ml) was subjected to oxidation by air bubbling at room temperature for 68 hours in 0.01M phosphate buffer at pH 7 to 8, ribonuclease activity reappeared to the extent of from 12 to 19 percent of the specific activity of native enzyme. The number of sulfhydryl groups per mole decreased during reoxidation. When partially reduced ribonuclease containing about four sulfhydryl groups per mole was reoxidized, there was no significant increase in activity or decrease in sulfhydryl groups. The results of all reoxidation experiments are summarized in Fig. 1. Native ribonuclease that was treated under these reoxidation conditions showed no change in activity, nor was activity regenerated in completely reduced, carboxymethylated ribonuclease under these conditions.

The disappearance of disulfide bridges from native ribonuclease during reduction, and their reappearance on oxidation of reduced enzyme, was followed

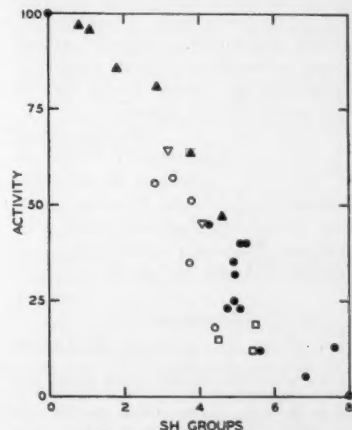


Fig. 1. Activity of ribonuclease at various stages of reduction (expressed as percentage of the specific activity of native ribonuclease) as a function of the number of moles of sulfhydryl groups per mole of enzyme.  $\blacktriangle$ , Reduction in absence of urea;  $\bullet$ , reduction in 8M urea;  $\square$ , reoxidation of fully reduced, inactive ribonuclease;  $\circ$ , reoxidation of samples containing more than six sulfhydryl groups per average molecule;  $\nabla$ , reoxidation of samples containing about four sulfhydryl groups per average molecule.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

qualitatively by subtilisin digestion (9) of the carboxymethylated protein and paper electrophoresis (10) of the digest. Native ribonuclease treated in this way (11) yields several bands which contain disulfide bonds as shown by the cyanide-nitroprusside test (12). The stepwise disappearance of these bands on reduction and their reappearance on oxidation of reduced ribonuclease have been observed. Identification of the disulfide-containing bands resulting from the digestion of reoxidized preparations with those produced from native ribonuclease, as well as elucidation of the order of cleavage of the disulfide bonds during the reduction of the native molecule, must await further investigation.

The S-shaped distribution of the solid points in Fig. 1 suggests the formation of enzymatically active products at intermediate stages of reduction. Further, this figure indicates that, with as many as four sulfhydryl groups per average molecule, activity remains high. With the appearance of more than this number of sulfhydryl groups, activity drops rapidly. Positive confirmation of the existence of enzymatically active reduction intermediates will depend on their separation and characterization.

Various covalent (9, 13), secondary (14, 15) and tertiary (15) bonds can be broken in ribonuclease without loss of enzymatic activity, thus suggesting that the "active center" of the enzyme might comprise only a relatively small part of the molecule (14, 16). It appears from the present work that not all of the disulfide bridges in ribonuclease are essential for enzyme activity. A further study of the intermediate stages of ribonuclease reduction may reveal specific disulfide bridges associated with the "active center" of this enzyme.

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\* On leave of absence from the Weizmann Institute of Science, Rehovoth, Israel.

1 February 1957

### Skin-Sensitizing Activity of Globulin Fractions from Rabbit Immune Serums

The intradermal introduction of certain rabbit immune serums into human beings, followed by challenge with antigen several days later, produces wheal and erythema reactions that are indistinguishable from those produced by challenge of sites prepared with human reaginic serum. It has been repeatedly found that skin-sensitizing activity and precipitin content of a given serum vary independently (1), and it has been suggested that skin-sensitizing antibodies might be nonprecipitating (2). From absorption experiments with an ovalbumin-rabbit antiovalbumin system, Vaughan and Kabat (3) have concluded that the antibody against the major antigenic component does not cause sensitization, but that antibodies against trace antigenic components are responsible.

The purpose of this investigation (4) was to determine whether skin sensitizing activity of rabbit immune serums is associated with the same globulin component as precipitating antibody, or whether, analogous to skin-sensitizing activity of human serums (5), the skin-sensitizing activity of rabbit immune serums might not also be associated with other than gamma globulin components. Our experiments were not designed to ascertain the antigenic component against which skin-sensitizing activity was directed—that is, whether it was directed against the major antigenic component or against trace antigenic contaminants.

Rabbit antisera were prepared against the following antigens: three-times-recrystallized chicken ovalbumin (Ea); crystalline bovine plasma albumin (BPA), Armour; crystalline hog chymotrypsinogen, Armour Lot No. 128-214; hemocyanin from keyhole limpet (*Megathura crenulata*); and three-times-crystallized bovine beta lactoglobulin. The rabbits received about 10 mg of antigen four times each week for 3 weeks and were bled 8 to 10 days after the last injection. All antisera and normal rabbit serum were divided into a number of aliquots and stored at  $-20^{\circ}\text{C}$  until used. The amount of precipitating antibody in each serum was determined by quantitative precipitin analyses using Nessler's reagent. Starch electrophoresis was performed in bar-

bit buffer at pH 8.6,  $\mu=0.1$ . The starch blocks were cut into 1-cm segments, and each was eluted with saline buffered at pH 7.1. Total protein analyses were performed by the quantitative biuret reaction (6).

The skin-sensitizing capacity of starch eluates and of controls consisting of diluted antiserum, normal rabbit serum, and starch electrophoresis eluates of normal rabbit serum was determined by passive transfer into human volunteers who had not been exposed previously to rabbit serum. Volunteers were carefully screened by preliminary intradermal tests in order to select only those who gave negative reactions to rabbit serum and antigen. Proper dietary instructions were given to all subjects and were reported to have been followed. Three or four days after the introduction of antiserum and antiserum fractions in 0.05-ml amounts, and in concentrations indicated in the Figs. 1, 2, and 3, the sites were challenged with 0.01 to 0.02 ml of 1-percent antigen in saline. Tracings on Scotch tape or paper were taken of most significant reactions, and in some cases reactions were photographed. The reactions were graded by appearance and average wheal diameter, according to the following scheme; negative, less than 5 mm; 1 plus, 5 to 7 mm, no pseudopods; 2 plus, 8 to 10 mm, small pseudopods; 3 plus, 11 to 14 mm, pseudopods; 4 plus, 15 mm or over, large pseudopods. In general, the diameter of the flare was twice that of the wheal.

Figures 1 to 3 are representative examples of the results obtained. The skin-test data represent the average reactions observed in three recipients. Data on the serum of one rabbit after 3 weeks of immunization with Ea, administered intravenously without adjuvant, are presented in Fig. 1, and on serum obtained after another 3 weeks of immunization of the

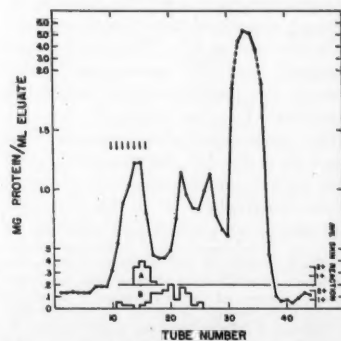


Fig. 1. Starch electrophoretic pattern of rabbit anti-Ea serum 261-1. Arrows indicate presence of precipitating antibodies. Block diagram A indicates skin reactions following intradermal introduction of eluates. Block diagram B indicates skin reactions 3 to 4 days later, following challenge of the prepared sites with antigen.



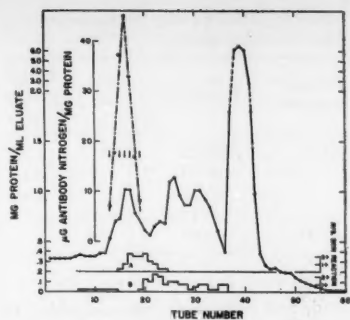


Fig. 2. Starch electrophoretic pattern of rabbit anti-Ea serum 261-2. Quantities of precipitating antibody in eluates are indicated. Block diagram A indicates skin reactions following intradermal introduction of eluates. Block diagram B indicates skin reactions 3 to 4 days later, following challenge of the prepared sites with antigen.

same rabbit, in Fig. 2. Figure 3 represents results obtained with the serum of one rabbit after 3 weeks of immunization with BPA, which was also administered intravenously without adjuvant. In each of the figures, the protein concentrations of the starch eluates are indicated by curve A. Arrows indicate the presence of precipitating antibody. Block diagrams A and B represent the intensity of the wheal and erythema reactions observed 20 minutes after the introduction of eluates (block diagram A) and 3 or 4 days later, following challenge with antigen (block diagram B). In addition, in Fig. 2, the results of quantitative precipitin analyses of eluates are indicated.

The type of reaction shown by block diagram A has not, to our knowledge, previously been reported. Within 20 minutes after the introduction of the eluates, a wheal and erythema response developed in some of the sites that was indistinguishable from that observed after challenge of sensitized skin with antigen. Normal rabbit serum or normal rabbit serum eluates produced either no visible reactions, or reactions so small that within the grading system we used they were considered negative. At the present time, we are inclined toward the idea that the responsible agent may be a circulating antigen-antibody complex in extreme antibody excess that is present in the serum of immunized rabbits. Efforts to identify the responsible material are presently underway.

We have also thought that this phenomenon might be related to reversed passive anaphylaxis resulting from the small amount of antigen (1 to 10 µg of antigen nitrogen) that was introduced (on the forearm) for preliminary skin testing. This, however, appears unlikely in view of the findings of Loveless *et al.* (7) that the reverse Prausnitz-Kuestner reaction with human reaginic serum re-

quires several times the amount of antigen that is required for the direct Prausnitz-Kuestner reaction. When preliminary skin tests with antigen were performed a week before the introduction of antiserum eluates, the immediate reactions (without challenge with antigen) occurred apparently unchanged in spite of the time interval. It is suggested that the "irritative" response elicited upon intradermal introduction of certain human serums (8) is a manifestation of the same phenomenon.

Block diagrams B indicate the wheal and erythema response of sensitized sites to challenge with antigen. The important findings are (i) that skin-sensitizing activity is associated with different electrophoretic fractions than precipitating antibody (9) and (ii) that skin-sensitizing activity is not associated solely with any one electrophoretic component, but with several.

It can be seen from Fig. 2 that skin-sensitizing activity is not demonstrable in eluates containing large amounts of precipitating antibody, while eluates containing no precipitating antibody were found to be the most strongly skin sensitizing. To exclude an antibody-excess inhibition phenomenon, eluates that were not skin sensitizing but which contained precipitating antibody were tested in various dilutions (1/2 to 1/100); in no case was skin-sensitizing activity demonstrable upon dilution. In the analysis of eluates of about 20 starch electrophoresis experiments of the serums of individual rabbits and of pooled serum, it was found that in about half of the volunteers in whom eluates were tested, wheal and erythema reactions were produced following the introduction of a few eluates from the anodic side of the gamma globulin maximum. The most frequently observed distribution of skin-sensitizing activity was that shown in Fig. 3, where maximum activity was associated with alpha-2 globulins, although, as in other serums, some activity was found in other components.

There appeared to be a relationship between the length of immunization and the heterogeneity of distribution of skin-sensitizing activity. The longer the immunization, the broader the distribution. Not enough serums have been analyzed, however, to establish this precisely.

The distribution of skin-sensitizing activity is particularly important when it is compared with the distribution of precipitin content of eluates. Precipitating antibody against the various antigens was found to be associated only with gamma globulins. The quantitative distribution of precipitating antibody content of eluates as indicated in Fig. 2 is certainly in accord with the hypothesis that precipitating antibody is electrophoretically homogeneous (10). It is in striking contrast to the heterogeneity of

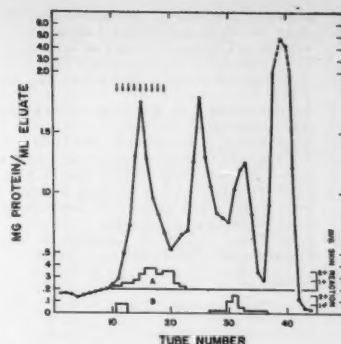


Fig. 3. Starch electrophoretic pattern of rabbit anti-BPA serum. Arrows indicate presence of precipitating antibodies. Block diagram A indicates skin reactions following intradermal introduction of eluates. Block diagram B indicates skin reactions 3 to 4 days later, following challenge of the prepared sites with antigen.

the electrophoretic distribution of skin-sensitizing activity.

In summary, it has been found that immune rabbit serums and certain starch electrophoresis fractions of immune rabbit serums can produce upon intradermal introduction in man and without challenge with antigen, immediate wheal and erythema reactions that are indistinguishable from the ordinary passive transfer reactions. Evidence has been presented that the components responsible for the skin-sensitizing activity of rabbit immune serums in man, as determined after challenge with antigen, are usually associated with more than one globulin component and are distinct from precipitating antibody. Rabbit antisera against all the antigens tested and mentioned have been found to elicit both types of skin reactions in man.

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22 January 1957

## "Nonviral" Tumors Produced in Turkeys by Rous Sarcoma Virus

The marked variability in the quantity of virus present in tumors of known viral etiology is well known and has been emphasized in recent reviews (1). In the case of the Rous sarcoma, Bryan *et al.* (2) have shown that the amount of virus extractable from the tumor is related to the initiating dose of virus. Indeed, when dilutions of Rous sarcoma virus were employed that produced tumors in less than half of the chickens, about 24 percent of such tumors yielded no recoverable virus at all. Duran-Reynals (3) found that tumors were produced in turkeys by Rous sarcoma virus and that these tumors could be transferred by means of cell suspensions or extracts through four serial passages in young turkeys, although some loss in potency was observed. The virus retained its infectivity for chickens

throughout its passage in turkeys. Harris (4) observed that although very young turkeys were susceptible to this virus, they became resistant after 3 weeks of age. Intravenous inoculation of chicken blood into newly hatched turkeys or embryonated turkey eggs markedly decreased the development of resistance.

Sarcomas produced in turkeys with as much as 10,000 ED<sub>50</sub> of chicken tumor virus yielded little or no extractable virus (Table 1), despite the fact that the dilution end-point for tumor production by chicken tumor virus was identical in chicks and turkeys. In these experiments, 0.2-ml amounts of serial decimal dilutions of standard Rous sarcoma virus that had been prepared from chicken tumor tissue by differential centrifugation (5) were inoculated subcutaneously into the wing web of groups of 10 to 20 chicks and turkeys, respectively. Unsexed white leghorn chicks and Beltsville white turkey poults 3 to 6 days of age were used, and the birds were examined daily for 4 to 6 weeks. As anticipated (3) the sarcomas produced in turkeys were grossly and histologically different from those produced in chickens. These tumors developed rapidly but, once they were established, they grew slowly, and metastases were almost invariably found in the liver when large amounts of virus were used. Two to 4 weeks after inoculation of virus, three turkeys from each dilution group were killed, and their tumors were stored at -70°C in glass-sealed ampoules. Later, each tumor was thawed and ground in a mortar with

Table 2. Serial passage of Rous sarcoma virus in turkey poults.

Passage number	Response	Latent period (day)
1	22/22	5.3
2	33/33	8.1
3	28/28	8.6
4	3/19	
5	0/25	

sand, and sufficient saline was added to make a 10-percent suspension by weight. Each suspension was clarified by centrifugation and inoculated subcutaneously into groups of 11 chicks each, which were examined daily for 4 weeks for the presence of tumors. It is clear that chicks and turkey poults were equally susceptible to Rous sarcoma virus but that the virus was present in appreciable quantities only in turkey tumors produced by large amounts of virus.

Table 2 shows that serial passage of Rous sarcoma virus in turkeys was associated with a progressive loss in potency with each passage until the fourth passage, when extracts of such tumors did not produce tumors in turkeys. Standard Rous sarcoma virus derived from chicken tumor tissue was used to initiate the first passage in turkeys. Ten-percent tissue extracts for the subsequent passages were prepared from pools of three turkey tumors each. The methods employed were the same as those described in the previous paragraph, except that the tumor tissue extracts were subjected to additional centrifugation (2) to remove any intact cells that might have escaped disintegration during freezing, thawing, and grinding. Extracts of tumors from the third passage produced tumors in only 15.8 percent of the turkeys, and these tumors contained no demonstrable virus.

In addition, 10-percent tissue extracts were prepared from two individual tumors and one pool of two tumors from the third serial turkey passage, and each of these was inoculated subcutaneously into groups of ten or more chicks each. Two of these extracts failed to produce tumors in chicks, but one extract contained a quantity of virus equal in potency to standard Rous sarcoma virus, indicating that such tumors can occasionally contain appreciable amounts of recoverable virus.

It is possible that the development of natural or acquired resistance in the turkey (4) and the effect of the initiating dose on the yield of extractable virus (2) both contribute to the low viral content of turkey tumors. In any event, the frequent production by Rous sarcoma virus of noninfective tumors in turkeys (6) resembles the so-called "masked" virus

Table 1. Production of "nonviral" tumors in turkeys by virus obtained from chicken tumor tissue.

Titration of Rous sarcoma virus					Inoculation of extracts of individual turkey tumors into chicks		
Virus diluted: (log)	Chicks		Turkeys		Tumor	Response*	Latent period† (day)
	Response*	Latent period† (day)	Response*	Latent period† (day)			
-1	19/20	4.5	15/15	2.4	a	11/11	5.0
					b	11/11	5.2
					c	11/11	5.3
					d	0/11	
-3	19/20	5.3	15/15	3.8	e	0/11	
					f	8/11	7.0
					g	0/10	
					h	0/10	
-5	20/20	6.4	15/15	5.7	i	2/10	
					j	2/11	
					k	4/11	> 15.0
					l	10/11	10.0
-6	17/20	8.2	14/15	6.6	m	0/11	
					n	0/11	
					o	4/11	> 15.0
					p	0/11	
-7	2/10		7/15				
-8	1/10		2/15				
-9			0/15				

\* No. developing tumors/total No. inoculated.

† Latent period is the time in days required to produce tumors in 50 percent of chicks inoculated (estimated graphically using probability paper;  $y = 100/\text{No. of days}$ ).

described by Shope (7) for papilloma virus in domestic rabbits and pseudorabies virus in cattle, as well as the neuropathic effect produced in mice by high dilutions of certain strains of Newcastle disease virus (8).

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7 January 1957

### Biological Concentration by Killer Clams of Cobalt-60 from Radioactive Fallout

After the March 1954 nuclear detonation in the Pacific Ocean, a number of the northern Marshall Islands were contaminated with radioactive fallout (1). Since that time, our laboratory has made periodic surveys of the area to evaluate the residual contamination in plants, marine and land animals, soil, and water (2). Among the specimens collected at two years postdetonation were two "killer" clams (*Tridacna gigas*) that were recovered from the shores of Rongelap Island (3).

The soft tissue of the clams was prepared for analysis by the dry-ash method at 500°C and dissolved in dilute acid. Measurements of gross activity on aliquots of the resulting solution revealed the presence of readily detectable amounts of both beta and gamma radiations.

Table 1. Cobalt-60 and gross gamma activity in killer clams.

Specimen	Wet Wt. (g)	Gamma Activity		Co <sup>60</sup> * (disintegrations/min)†
		Gross count/min	Co <sup>60</sup> (count/min)	
A	1800	142,700	90,300	210,000
B	882	356,700	303,000	705,000

\* Corrected for recovery.

† The disintegrations per minute were determined by comparison with a Co<sup>60</sup> source obtained from the National Bureau of Standards.

tions. As an aid to identification, the samples were subjected to gamma spectrum analysis in a single-channel analyzer. Gamma photons of energies 1.17 and 1.33 Mev which are identical with those of Co<sup>60</sup> were observed. Confirmation of the presence of this nuclide was sought by chemical separation and by additional radiation characterization.

To establish the reliability of the analytic procedure, a preliminary experiment was devised for evaluating the exchange of Co<sup>60</sup> with cobalt carrier and the decontamination efficiency from other radioactive elements. Cobalt-60 tracer and cobalt carrier (CoCl<sub>2</sub>) were added to a 1-month-old solution of mixed fission products. A control was maintained in which the addition of Co<sup>60</sup> was omitted. The solution was twice scavenged with ferric hydroxide, using ammonium hydroxide for alkalization and complexation. The cobalt was then precipitated with  $\alpha$ -nitroso- $\beta$ -naphthol (4). Recovery was determined by the colorimetric nitroso-R salt method (5).

The reliability of the analytic procedure was evident from the results of the preliminary experiment. Cobalt was decontaminated from mixed fission products with 99 percent efficiency, and exchange was complete with a 20-percent yield of both carrier and activity.

This analytic procedure was applied to the specimens. The results of analysis are given in Table 1. For the purpose of comparison, the gross gamma count is also included. The data clearly indicate that the greater fraction of the gamma activity was attributable to Co<sup>60</sup>. In specimens A and B, the activity contributed by this nuclide was 63 and 85 percent of the gross gamma activity, respectively.

To establish the identity of the isolated activity unequivocally, the radiations were characterized by aluminum and beryllium absorption curves and by analysis of the gamma spectra. In each case the characteristics were identical with those of an authentic sample of Co<sup>60</sup>.

The appearance of readily measurable quantities of Co<sup>60</sup> in the killer clam is noteworthy from two aspects. First, Co<sup>60</sup> is not a component of fission products. It is therefore assumed that this nuclide was induced from an environmental precursor by the neutron flux accompanying the nuclear detonation. A possible precursor is natural Co<sup>59</sup>, which, when bombarded by neutrons, undergoes the typical (n,  $\gamma$ ) reaction to form Co<sup>60</sup>. More importantly, this radioelement was not detected in the numerous fallout-exposed materials analyzed at one year postdetonation (1). Presumably the induced activity was present only in trace amounts. The accumulation of Co<sup>60</sup> from an environment which for all intents and purposes was infinitely dilute

points to the enormous concentrating capacity of the killer clam. Experiments are currently underway to establish whether this property is common to all bivalves.

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7 January 1957

### Observations on a Fast-Moving Protein in Avian Malarial Serum

The alterations occurring in the electrophoretic patterns of the serum proteins of men and animals infected with the malaria parasite have been extensively investigated by the now classical moving-boundary method of Tiselius. The results of these studies have been summarized by Stauber (1) in a recent review of the application of electrophoretic techniques in the field of parasitic diseases. In general, no qualitative changes have been proved, but decreased albumin and increased globulin, particularly alpha-2 and gamma globulin, have been shown to occur. This preliminary report describes a marked qualitative change, which was found by utilizing filter-paper electrophoresis, that occurs in the serum protein patterns of pigeons infected with the 1PI-1 strain of *Plasmodium relictum* (2)—namely, the appearance of a new component possessing an electrophoretic mobility greater than that of albumin.

Paper electrophoresis offers an important advantage over the Tiselius method because it requires an extremely small sample for analysis. It is thus ideally suited to the serial examination of the blood proteins of small laboratory animals without material interference with the usual course of an induced infection. A modification of the horizontal open-strip method of Grassmann and Hannig (3) was employed in these studies. Four-hundredths of a milliliter of serum was applied by micropipet to Whatman No. 1 filter paper strips (35 by 3.75 cm) immersed in a Veronal-acetate buffer of pH 8.6 and ionic strength 0.1. A constant current of 0.5 ma per centimeter of paper width was applied for a period of 19 hours at room temperature (23 to



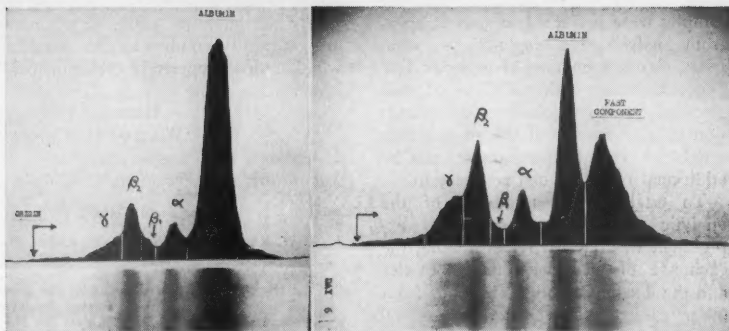


Fig. 1. Comparison between the protein patterns of normal pigeon serum (left) and malarial (right) pigeon serum. The stained strips are shown below the corresponding Analytrol recording.

25°C). Upon completion of the run, the strips were allowed to air-dry for 15 minutes; then they were oven-dried at 70°C for 2 hours and subsequently stained with bromphenol blue for proteins, or with Oil Red O for lipids. Analyses of the stained strips were performed in the Spinco Analytrol, an automatic recording and integrating densitometer.

Figure 1 represents a comparison between the protein patterns of normal and malarial pigeon serum. Normal pigeon serum separates into five distinct bands, whose disposition and intensity are quite similar to the patterns reported for human and other vertebrate serums (4). The malarial pattern reveals that gross qualitative and quantitative changes take place as a consequence of the infection. The globulins, particularly gamma globulin, are increased, and the albumin fraction is drastically reduced

(5). In addition, a new component is evident, whose electrophoretic mobility is greater than that of albumin. It is important to note, however, that this is not the picture of malarial serum per se; it is characteristic of pigeon malaria only during a particular and transient stage in the infection.

This feature was clearly shown when nine pigeons were inoculated with equivalent doses of parasites, and 1 ml of blood withdrawn from each bird daily for a period of 20 days, or until death intervened. A typical series of strips is shown in Fig. 2, where the daily changes occurring in the serum proteins of an infected pigeon may be serially followed. No comparable alterations in the serum proteins were detected in normal birds similarly studied. The fast component emerges early in the infection as a smear on the front of the albumin. It gradually

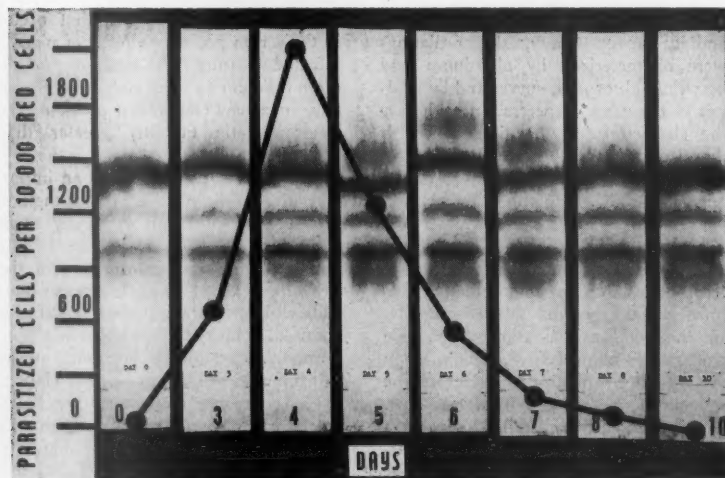


Fig. 2. A typical series of strips showing the daily changes occurring in the serum proteins of an infected pigeon. The preinoculation pattern is shown at the extreme left; the patterns for days 3 through 10 follow. Anodal migration is upward in the figure. The superimposed parasitemia curve represents the intensity of the infection as revealed by counts on daily blood smears stained with Giemsa.

increases in concentration, clearly separates from the albumin, and then progressively disappears, all within the space of a few days.

The superimposed parasitemia curve indicates that the fast component reaches its greatest concentration and maximum separation from albumin after the peak of parasitemia has been passed—that is, during the time that the parasite number is diminishing. It is interesting to note that this is also the period when young red cells are present in the largest numbers in the peripheral blood, as a consequence of the erythropoietic hyperplasia induced by the acute hemolytic anemia so characteristic of malaria in birds (6). This fact is highly suggestive of a correlation between stimulated erythropoiesis and the appearance of the fast component in the serum of the pigeon.

Hemolysis of normal pigeon blood by mechanically rupturing the red cells, thus liberating hemoglobin and free nuclei into the serum, did not result in the electrophoretic resolution of a prealbumin component. However, when hemolytic anemia and erythroblastosis were produced in uninfected pigeons by the oral administration of phenylhydrazine hydrochloride, a fast moving protein resembling that described for malaria appeared shortly after initiation of the drug regimen and disappeared soon after cessation of treatment.

The prealbumin fraction of the malarial serum exhibited a blue fluorescence when it was viewed under ultraviolet light, and it stained intensely with Oil Red O, demonstrating that lipid is associated with it. The fast component was isolated by electrophoresis on paper, and its absorption spectrum, as measured in the Beckman spectrophotometer, showed a marked resemblance to that of malarial pigeon albumin, with a maximum at approximately 2800 Å and a minimum at approximately 2550 Å (7).

The findings reported here clearly depict the elaboration of a lipoprotein substance in the serum of pigeons infected with *Plasmodium relictum* whose electrophoretic mobility is greater than that of albumin. The substance seems to be correlated with the erythroblastosis produced by the infection. The similar observations reported for phenylhydrazine poisoning in pigeons would indicate that this phenomenon is a host reaction to pathological disturbances, erythropoietic or hepatic in nature, or both, which may be occasioned either by parasite invasion or drug administration. Additional studies are in progress to characterize the fast component in greater detail, and to clarify further the mechanisms responsible for its elaboration.

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22 January 1957

## Concerning the pH Dependence of Enzyme Reactions on Cells, Particulates and in Solution

Considerable attention is being given to the localization of enzymes in and on cells (1, 2). Attention has been called to the similarity between the pH activity curves of certain enzyme reactions in intact cells and mitochondria (3) and in solution. Because of this similarity it has been suggested, for example, with trehalase, lactase, and invertase of yeast, that the enzymes concerned must be peripherally located in the cell. The assumptions are (i) that the internal pH of the cell is almost independent of the external pH of ambient buffer, (ii) that the permeability of the cell membrane to substrate is independent of pH, and (iii) that the extremes of pH do not kill the living cells. The assumptions are all valid with yeast (2, 4). More recent work with a different approach has verified the conclusion that invertase is located on the surface of yeast cells (5).

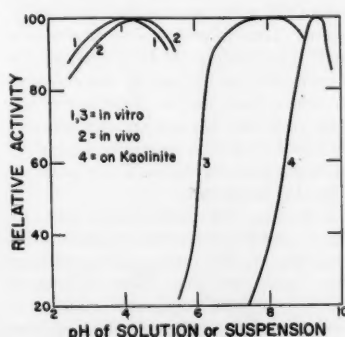


Fig. 1. The effect of pH on invertase activity of yeast cells and isolated enzyme (1, 2) and on chymotryptic activity in solution or adsorbed on kaolinite (3, 4).

It is noted here, however, that, if the surface carrying an enzyme is charged, owing to the presence of a polyelectrolyte, one cannot expect that the pH for optimum activity of an enzyme will be the same for the enzyme on the surface as compared with the action of the enzyme in solution. A charged surface of a cell or particle will either attract or repel hydrogen ions, depending on the sign of the charge, in an ionic double layer at the surface. An enzyme acting at a surface will thus be exposed to, and in equilibrium with, a hydrogen-ion activity differing from that of the ambient buffer. A comparison of the action of chymotrypsin on a protein in solution and on the surface of kaolinite particles (about 1  $\mu$  in size) is a case in point (Fig. 1) (6). The pH optimum for the enzyme on the surface is at a higher pH, and the pH of half maximum activity is shifted two units toward higher pH, indicating that the hydrogen-ion activity at the surface is about 100 times greater than in solution (7). In Fig. 1 data are also plotted from the paper of Wilkes and Palmer (4) for the effect of pH on invertase activity of yeast cells and of isolated enzyme. Again, the influence of surface is discernible, although less markedly (8). As with kaolinite, the data indicate that the surface of yeast has a negative charge density in the pH range shown (9).

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24 January 1957

## Enhancement of Oxidative Esterification of Inorganic Phosphate by Clinical Insulin

In an earlier communication (1) it was reported that the addition *in vitro* of Lilly clinical plain insulin increased the oxidative esterification of inorganic phosphate by rabbit tissue (kidney and

Table 1. Effects of the additions of clinical plain insulin and glycerol on the oxidative esterification of inorganic phosphate by rat liver homogenates.\*

Experiment No.	Inorganic phosphate esterified (mg)		
	Control	Insulin	Glycerol
1	0.442	0.626	0.682
2	0.498	0.626	0.664
3	0.442	0.591	0.615
4	0.591	0.701	0.720
5	0.536	0.645	0.645
6	0.404	0.572	0.553

\* Tissue preparation: Overnight-fasted rats were killed by decapitation, and the liver was quickly removed and chilled on cracked ice for 2 to 3 min. The chilled tissue was homogenized in an all-glass homogenizer with 3 vol of isotonic (0.9 percent) KCl for 5 min at 0°C. The homogenate was centrifuged in the cold for 2 min and the supernatant was used in the experiments. Method: Essentially the same as that used in the earlier communication (1). Each manometer vessel contained, in the side arm, 0.2 ml of 5 percent glucose and 0.1 ml of 0.2M MgCl<sub>2</sub>, and, in the main compartment, 0.2 ml of 0.2M Na<sub>2</sub>HPO<sub>4</sub>, pH 7.5, 0.1 ml of 0.5M NaF, 0.2 ml of 0.01M adenosine-5-phosphate, 0.1 ml of 0.00025M cytochrome c, 0.2 ml of 0.5M sodium succinate, and water to make a final volume of 2.5 ml. When insulin or glycerol was added, 0.05 ml of water in the main compartment was replaced by the same volume of a 40  $\mu$ /ml clinical plain insulin (Lilly or Wellcome) or a 1.6 percent glycerol solution in distilled water acidified to pH 3.3 by HCl. Duration of experiment, 15 min; gas phase, air; temperature 38°C. Wellcome insulin was used in experiments 1, 2, and 3 and Lilly insulin was used in experiments 4, 5, and 6.

liver) homogenates and extracts. It was subsequently found that similar enhancement could also be obtained with rat kidney and liver homogenates but not with rat brain homogenates. It was further observed that the Wellcome plain clinical insulin also gave similar results. Crystalline insulin (Lilly or Wellcome), however, had no such effect. This suggested that some component of the solvent used in the manufacture of clinical insulin was possibly responsible for the observed effect. Inquiry showed that the solvent now used in the manufacture of clinical insulin contains appreciable amounts (1 to 2 percent) of glycerol. Glycerol is known to act as a phosphate acceptor during aerobic oxidation in rabbit kidney homogenates (2). Thus, it appeared that the enhancement of esterification of inorganic phosphate during oxidation by clinical insulin was possibly caused by the presence of glycerol in the insulin.

Table 1 compares the effects of clinical plain insulin (Lilly and Wellcome) and glycerol on aerobic esterification of inorganic phosphate by rat liver homogenates. The results clearly show that the enhancement of the esterification of inorganic phosphate by clinical insulin is caused by the glycerol present in the insulin solution, which acts as an extra phosphate acceptor in the system (3). Rat brain tissue possibly does not con-

tain the enzyme which brings about the phosphorylation of glycerol; hence, clinical insulin had no effect in experiments with rat brain homogenates.

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4. I wish to express my gratitude to F. G. Young for his kind interest in this work and for granting the use of laboratory facilities. My best thanks are due to C. G. Pope of the Wellcome Physiological Research Laboratories for helping me to obtain samples of the Wellcome insulin. Samples of the Lilly insulin were kindly donated by A. J. Kenny of this department. My thanks are also due to the Imperial Chemical Industries Fellowship Fund, University of Cambridge, for the grant of a fellowship.

22 January 1957

### Influence of Prenatal Maternal Anxiety on Emotionality in Young Rats

The purpose of the observations reported in this article (1) was to test the hypothesis that emotional trauma undergone by female rats during pregnancy can affect the emotional characteristics of the offspring. By now, a good deal of evidence favoring this possibility has accumulated from diverse sources, including teratology (2), pediatrics (3), experimental psychology (4), and population biology (5). While none of the studies done has directly confirmed this hypothesis, many of them indicate that such hormones as cortisone, adrenalin, and adrenocorticotrophic hormone, injected into the mother during preg-

nancy, have drastic effects on the fetus via the maternal-fetal blood exchange. Since strong emotion may release such substances into the mother's blood stream, there are grounds for supposing that it may have an important influence on fetal behavioral development. This experiment was the first in a projected series designed to examine this question in detail.

The rationale of the procedure was to create a situation which would predictably arouse strong anxiety in female rats, and to provide them with a standard means of reducing this anxiety; then to expose them to the anxiety-arousing situation during pregnancy, but block the accustomed means of escaping it. The assumption was that strong, free-floating anxiety would be generated in the pregnant females, and that any endocrine changes resulting would be transmitted through the maternal-fetal blood exchange to the fetus. The experiment was done by training five randomly chosen female hooded rats in a double compartment shuttlebox, first to expect strong shock at the sound of a buzzer, and then to avoid the shock by opening a door between the compartments and running through to the safe side. When the rats had learned this, the five experimentals, together with five control females, were mated to five randomly chosen males in a large cage. As soon as the experimentals were found to be pregnant (by vaginal smears), they were exposed to the buzzer three times every day in the shock side of the shuttlebox, but with the shock turned off and the door to the safe side locked. This procedure was terminated by the birth of a litter. The controls were placed in breeding cages during the same time.

Possible postnatal influences were controlled by cross-fostering in such a way as to yield a design with six cells, each containing ten offspring with two main

variables—namely, prenatal and postnatal treatment. The data obtained from tests given to the young were examined by means of analysis of variance. In all tests of significance, three error estimates were used: the within-cell variance, the within-plus-interaction variances, and the within-plus-interaction plus between-postnatal-treatment variances. Thus, as shown in Table 1, all tests of significance reported involve three *F* values.

The emotional characteristics of the 30 control and 30 experimental offspring were compared by two tests given at 30 to 40 and 130 to 140 days of age. In test A, measures of amount and latency of activity in an open field were taken in three daily sessions of 10 minutes each. In test B, emotionality was measured by latency of leaving the home cage, and latency of reaching food at the end of an alley way leading out from the cage after 24 hours' food deprivation. In the second test, the maximum time allowed an animal to reach food was 30 minutes. In the measures used, low activity and high latency were taken as indices of high emotionality.

The results are summarized in Table 1. On test A, striking differences between experimentals and controls were obtained in amount of activity, both at 30 to 40 days and at 130 to 140 days. On the first testing, a significant interaction was obtained which probably represents genetic variation. On the second measure, experimental animals showed a much higher latency of activity than controls at both ages of testing. In neither of these activity measures were there any significant differences due to postnatal treatment or interaction besides the one mentioned.

In test B, experimental animals were slower to leave the home cage than controls at the first age of testing. There was no significant difference between groups in this measure, however, at 130 to 140 days of age. Similarly, experimentals showed a much higher latency than controls in getting to food at the end of the alley way at the first age of testing. The difference was less at the later age of testing. At both ages, significant interaction variances were found. As before, both may well be due to genetic variation. On neither of the measures used in test B were any significant differences found between methods of postnatal treatment.

It is clear from this analysis that the experimental and control animals differ strikingly on the measures of emotionality used, and that these differences persist to a great extent into adulthood. While there is no question about the reliability of these differences, there is some ambiguity regarding their cause. Thus, we do not know exactly how the stress used had effects. It is possible that

Table 1. Comparison of experimental and control animals on two tests of emotionality.

Item	Test A		Test B	
	Amount of activity (distance)	Latency of activity (seconds)	Latency to leave cage (minutes)	Latency to food (minutes)
<i>Tests given at age 30 to 40 days</i>				
Experimentals	86.0	146.3	14.9	23.7
Controls	134.5	56.8	5.2	11.8
<i>F</i> values	(15.79, 14.21, 13.57)	(8.51, 7.91, 8.07)	(16.13, 16.46, 15.62)	(31.73, 25.66, 25.87)
<i>p</i>	<.001	<.01	<.001	<.001
<i>Tests given at age 130 to 140 days</i>				
Experimentals	114.5	71.5	4.8	11.6
Controls	162.3	26.8	2.1	6.2
<i>F</i> values	(9.77, 9.12, 8.76)	(4.95, 4.79, 4.57)	(2.39)	(4.48)
<i>p</i>	<.01	<.05	>.05	<.05

the buzzer was strong enough to act on the fetuses directly rather than indirectly by causing release of hormones in the mother. Only a more careful repetition of the experiment will throw light on this problem.

A more serious objection than this is that, besides the main factor of prenatal stress, genetic variation could also have been responsible for the offspring differences if there had been inadvertent selection of nonemotional mothers for the control group and emotional mothers for the experimental group. However, several points argue against this possibility. Choice of female animals for the two groups was carried out randomly, and at least some of the genetic variance was included in the error estimates used to test the main effects. Further, an examination of scores within and between individual litters indicates that interlitter variances tend to be smaller than intralitter differences. This means that, in the population used, genetic variation was relatively slight compared with environmental variation. Consequently, it is improbable that even if accidental selection had occurred it could have resulted in an experimental group genetically very different from the control group.

Accordingly, we may state that there are some grounds for supposing that prenatal maternal anxiety does actually increase the emotionality of offspring. This conclusion is offered tentatively until further experimentation has been completed.

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25 January 1957

#### Occurrence of Pteridines in a Blue-Green Alga

In the course of photochemical studies on the blue-green algae a loss of photosynthetic activity in *Anacystis nidulans* was observed when an aerated suspension of cells in water was allowed to stand for a short period at 4°C in dark-

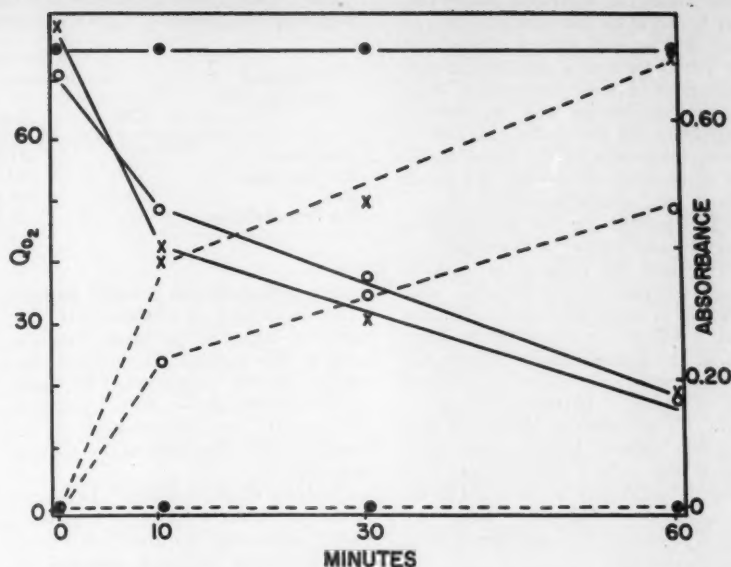
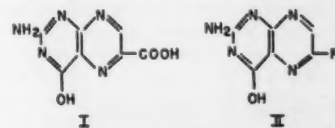


Fig. 1. Loss of photosynthetic activity and release of pteridines at 4°C. Cells of *A. nidulans* were grown in a continuous-culture chamber in medium C (4), washed and suspended in distilled water, and incubated at 4° or 25°C. At indicated times, aliquots were removed and centrifuged. Supernatants were examined in a 1-cm cell with a Beckman spectrophotometer. The packed cells were diluted in Warburg buffer No. 9 and their rate of photosynthesis was measured in saturating light from red neon. Solid lines,  $Q_{O_2}$  of photosynthesis ( $\mu\text{l}/\text{mg hr}$ ); dotted lines, increase in absorbance at 270  $m\mu$ ; O and X, cells incubated at 4°C, duplicate experiments; ●, control cells at 25°C.

ness. Paper chromatographic examination (butanol, acetic acid, and water, 4:1:5 by volume) of the supernatant (leach) after removal of the cells revealed the presence of a number of fluorescent materials. In addition several areas could be seen which reacted with ninhydrin. Of these, the only area in quantity appeared to be glutamic acid. No ultraviolet quenching, no organic phosphate compounds, and no phycocyanin or chlorophyll could be detected.

Aeration of the crude leach intensified its light yellow color. Its absorption spectrum revealed a major peak at 270  $m\mu$  and a smaller one at 410  $m\mu$ . The principal fluorescent material in the leach has been isolated from whole cells as a crystalline yellow compound in a yield equivalent to 0.05 to 0.1 percent dry weight of cells. Its ultraviolet absorption spectrum showed peaks at 285 and 400  $m\mu$  in 0.1N hydrochloric acid and at 268 and 430  $m\mu$  in 0.1N sodium hydroxide. On treatment with potassium permanganate in 0.1N sodium hydroxide (1) the yellow compound yielded 2-amino-4-hydroxy-6-carboxypteridine (I), and this same compound was obtained in the same manner from what appeared to be the principal blue fluorescent material. Another blue fluorescent compound has been identified spectrophotometrically and chromatographically as 2-amino-4-hydroxypteridine.

Thus all fluorescent materials appear to be closely related and to have the general structure II. Work is continuing on the elucidation of the structural formulas of these compounds.



A parallel relationship between loss of photosynthetic activity of cells subjected to 4°C and increase in absorbance at 270  $m\mu$  of the resulting aerated leach was demonstrated by the experiment illustrated in Fig. 1. The absorbance at 270  $m\mu$  was taken as a measure of total pteridine released (see ultraviolet absorption data given in a preceding paragraph). The value for total pteridine released from the cells during cold treatment is approximately the same as that recovered in crystalline form. Separate experiments showed that quinone Hill activity after 60 minutes' incubation of cells at 4°C was affected in a manner similar to photosynthesis.

The general occurrence of pteridines in relatively large concentrations in blue-green algae was indicated by paper chromatographic examination of three other species (*Anabaena variabilis*; *Nostoc muscorum* Gerloff; and *Nostoc musco-*



rum Allison). A fluorescent pattern similar to that of an *Anacystis* leach was observed in aqueous extracts of cells made at 100°C for 2 to 4 minutes and chromatographed in the same solvent. Widespread distribution and an essential metabolic role are further indicated for these compounds by the recent finding of an unconjugated pteridine as a growth factor for *Crithidia fasciculata* (2).

The parallel loss of photosynthetic activity and release of pteridines, together with the presence of relatively large concentrations of pteridine compounds in these photoautotrophs, suggest a role in the photosynthetic apparatus. The dramatic susceptibility to cold shock seen here in *Anacystis* is considered to be related to its thermotolerant nature. No precedent is known for such extreme cellular lability under what would seem to be a mild condition. The possible significance of pteridines in the metabolism of blue-green algae and other photosynthetic organisms is being investigated (3).

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4 February 1957

#### Distribution of Radioactivity in Cholesterol-C<sup>14</sup> of Different Origins

The positions of the radioactive carbon atoms in the molecule of cholesterol-C<sup>14</sup> made by biosynthesis from acetate-C<sup>14</sup> have been established by the well-known classical experiments (compare review by Cornforth, 1), which, however, were made with cholesterol that was obtained exclusively from the incubation of rat liver slices with acetate. In view of the varying patterns of distribution of radioactivity in cholesterol biosynthesis in different species and in different tissues (2), the question may be raised whether, in species other than the rat and under conditions different from those of the *in vitro* experiment with liver slices, the pathway of synthesis would be the same and thus give the same distribution of C<sup>14</sup> in the radio-

Table 1. Radioactivity in cholesterol-C<sup>14</sup> from different sources. CH, cholesterol-C<sup>14</sup>; DA, dehydroepiandrosterone-C<sup>14</sup>; DAA, dehydroepiandrosterone-C<sup>14</sup>-acetate.

Origin of cholesterol-C <sup>14</sup>	Radioactivity (count/mmmole min × 10 <sup>6</sup> )			CH/DA	CH/DAA
	CH	DA	DAA		
Intact rat	42.9	31.1	32.4	1.38	1.33
Rat liver slices	58.0	42.4		1.37	
Hen	138.0	108.4		1.27	
Pig liver perfusion	33.2	23.4	24.4	1.42	1.36

active cholesterol that is finally formed. The availability of cholesterol-C<sup>14</sup> of different origins permitted an investigation of this question. The method employed was the comparison of the count of dehydroepiandrosterone-C<sup>14</sup> prepared by chromic acid oxidation of cholesterol-C<sup>14</sup> with the count of the starting material (3).

Samples of cholesterol-C<sup>14</sup> had been obtained in experiments with acetate-1-C<sup>14</sup> as described in earlier papers from this laboratory (2) and consisted of small amounts that had been purified through the dibromo compound and recrystallized from methanol for counting purposes. Before oxidation, each sample was diluted with enough nonradioactive cholesterol (purified through the dibromo compound) to give about 5 g and then again purified by bromination, and so forth, and finally recrystallized from methanol to make 3 to 3.5 g available for oxidation. The following samples were used: (i) from whole rats that had been previously injected intraperitoneally with acetate-1-C<sup>14</sup>; (ii) from rat liver slices incubated as usual in Krebs-Ringer buffer (a total of 326.6 mg was diluted with 4.7 g of pure cholesterol); (iii) from intact hens (the acetate-1-C<sup>14</sup> was injected intraperitoneally and the cholesterol-C<sup>14</sup> isolated only from the liver and the gastrointestinal tract was used; a total of 2.1 g was mixed with 3.1 g of pure cholesterol); (iv) from perfusions of pig livers (a total of 790 mg was mixed with 4.21 g of pure cholesterol).

The oxidation of the purified samples was carried out, and dehydroepiandrosterone-C<sup>14</sup>-acetate semicarbazone was isolated as described (4). The semicarbazone was split with pyruvic acid to obtain the steroid acetate by following the directions of Hershberg (5). The crude reaction product was purified by chromatography over silica and by repeated recrystallization from ether-pentane. Free dehydroepiandrosterone was obtained by hydrolysis of the acetate with alcoholic KOH and was again purified by chromatography on silica and by recrystallization from ether-pentane, methanol-water, and methanol.

Samples of the substances were com-

busted for the assay, and C<sup>14</sup>O<sub>2</sub> was collected as BaC<sup>14</sup>O<sub>3</sub> and counted with an end-window counter. All counts were corrected to infinite thickness, but since only relative values were required, no correction was applied for dilution and other factors.

According to the accepted mechanism of cholesterol biosynthesis from acetate-1-C<sup>14</sup>, and in agreement with experimental findings (1), all radioactive carbon atoms of cholesterol and therefore also of the dehydroepiandrosterone obtained therefrom have the same count. Consequently, the quotient of the total specific activity of 1 mole cholesterol-C<sup>14</sup> over the total specific activity of 1 mole dehydroepiandrosterone-C<sup>14</sup> should be equal to the quotient of the number of radioactive carbon atoms of the two substances. Because the dehydroepiandrosterone represents the four-ring nucleus, this quotient mirrors the distribution of radioactivity in the molecule of cholesterol-C<sup>14</sup>. When acetate-1-C<sup>14</sup> is used as in the experiments of this report, the quotient should be 12/9 or 1.333. Table 1 gives the results obtained. The figures show that, for samples of cholesterol-C<sup>14</sup> derived from different sources, the same quotient, nearly identical with the theoretical quotient, is found; this indicates that the pathway of biosynthesis is the same for cholesterol of various origins. The different patterns of distribution of this substance in biological experiments must therefore be caused by other factors.

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#### References and Notes

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22 January 1957



## Book Reviews

**Some Protozoan Diseases of Man and Animals: Anaplasmosis, Babesiosis, and Toxoplasmosis.** Annals of the New York Academy of Science, vol. 64, art. 2, pp. 25-277. New York Academy of Science, New York, 1956.

This series of papers is the result of a conference on Some Protozoan Diseases of Man and Animals: Anaplasmosis, Babesiosis, and Toxoplasmosis, held by the Section of Biology of the New York Academy of Science, 17-18 Nov. 1955 and is published in book form by the academy.

In the first of the three parts of the book, present knowledge of anaplasmosis is summarized in four papers which deal, variously, with the clinical signs, diagnosis, transmission, prevention, and treatment of the disease. Among the diverse aspects of anaplasmosis discussed are, *in utero* transmission; the important role of the horsefly in transmission; the proposed eradication of the disease from the Hawaiian Islands with the use of the complement fixation test; and treatment with chlortetracycline and oxytetracycline.

The first paper of part II is a review and classification of the piroplasms of domestic animals, by Neitz. Two classificatory lists, one of the Piroplasmidea and another of the Leucosporidea, are given, as well as a series of tables which list the known arthropod vectors of the piroplasms. Babesiosis of domestic animals is reviewed by Malerbe, and cases in the dog are cited as representative of typical syndromes of all domestic animals affected with babesiosis.

In part III, toxoplasmosis, in man and animals, is discussed with respect to the propagation, morphology, and biology of the organism and the laboratory diagnosis and pathogenesis of the disease. The advantages and disadvantages of various methods of propagation, photomicrographs and detailed morphological descriptions, and the biology of Toxoplasma, are presented by Jacobs. Although the pathogenesis, discussed by Frenkel, deals mainly with the disease as it is seen in man and in experimental animals, the principles of the disease processes set forth are the same in the domestic animals, especially in the dog. Eyles mentions two groups of drugs—the sul-

fonamides and the 2,4'-diaminopyrimidines—which show promise in the treatment of toxoplasmosis. He points out, "Although possessing marked activity individually, perhaps the most outstanding characteristic of the sulfonamides and pyrimethamine is that they act together synergistically . . .," making therapeutic effects possible with lower doses of the drugs. Extensive bibliographies are listed by Frenkel and by Eyles.

R. L. FARRELL  
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**Handbuch der Physik.** vol. XV, *Low Temperature Physics II.* S. Flügge, Ed. Springer, Berlin, 1956. 477 pp. Illus.

This volume, the second of two devoted to the subject of low temperature physics and comprising five sections in almost 500 pages, is a worthy companion to the first (volume XIV).

In the opening chapter, on "Low temperature magnetism," J. van den Handel has written a short review to serve as an introduction to more extensive individual treatments elsewhere in the *Handbuch*. It is mainly devoted to the topics of energy levels, susceptibility, and antiferromagnetism, with additional brief remarks on resonance and relaxation phenomena and the Faraday effect.

There follows a discussion of "Adiabatic demagnetization," by D. de Klerk, which covers in detail all aspects, pure and applied, of the subject. One defect of this chapter is the fact that the author has striven to summarize practically every investigation ever reported rather than exercise critical selection. For example, the inherent inaccuracy in absolute temperature determinations below 1°K is rather lost sight of in a plethora of tabulations for many substances, some significant but others less so. It is interesting to learn that the latest (and as yet unpublished) data remove long-standing discrepancies between temperature determinations using gamma-ray heating and those using alternating-current absorption heating and resolve the argument in favor of the former. This automatically raises the question of the validity of all determinations which

have employed the alternating-current method, but this point is not discussed. These observations aside, the fact that the whole field of magnetic cooling, including application of the method to diverse investigations at very low temperatures, is so well covered (up to the end of 1954) makes this contribution a reference work of great value.

"Superconductivity" is dealt with in two chapters, one by B. Serin, which concentrates on experimental results, and another by J. Bardeen, which is devoted to theory. The former is very readable but a little uneven in emphasis, since half of the article is devoted to general properties, and the rest, to the specific topics of penetration depth, interphase surface energy, and thermal effects, with a few remarks about alloys and compounds. Bardeen describes in considerable detail the developments due, variously, to F. and H. London, Fröhlich, Pippard, Ginsburg, and Landau, and to himself. He deals with them under three headings: London theory and generalization, boundary effects and the intermediate state, and electron-phonon interactions. He ably demonstrates the large effort that has gone into the approach to an understanding of the superconducting state, while emphasizing the considerable distance that yet remains to be traveled. (One hopes that current rumors of a significant advance will presently be borne out by fact.)

In the final section, K. Mendelssohn discusses "Liquid helium." After an eloquent and at times philosophic introduction, the author deals authoritatively with the various thermal, mechanical, and rheological phases of the subject and with the "special" behavior of helium-3.

When viewing the volume as a whole, one can be enthusiastic, and grateful for its appearance. Perhaps other reviewers will find specific criticisms in the area of their special competence, but I am forced to believe that these will be minor ones.

R. P. HUDSON  
National Bureau of Standards

**Youth in a Soundless World.** A search for personality. Edna S. Levine. New York University Press, New York, 1956. 217 pp. \$5.

This book is about the deaf. It discusses in the introductory sections the general problem of the effects of deafness on adjustment, as well as psychological studies on the deaf. The major portion of the book is devoted to an experiment on deaf adolescent girls.

The experiment reported in the book consisted of the administration of the Wechsler-Bellevue scale, form 1, and the Rorschach test to 31 girls at the

Lexington School for the Deaf. The girls were 15 to 18 years of age and were selected as normal girls by their teachers. The Wechsler results were compared with a sample of 100 records of 16-year-old subjects from the Wechsler standardization data.

The results showed no statistically significant difference between the deaf and hearing groups in the over-all Wechsler IQ. On the other hand, the hearing group was superior to the deaf on the verbal scale, while the deaf were superior to the hearing group on the performance scale. The author concludes, after an analysis of the subtests, that the deaf are quantitatively inferior to the hearing group in verbal abstract thinking and superior in reactions to the concrete type of test stimulus. The Rorschach results likewise showed in the deaf a "non-creative, reproductive type with lowered capacity for conceptual thinking and strong emphasis upon concrete, tangible stimuli."

The study as a whole suffers from the usual difficulties encountered by psychologists in obtaining a representative sample of deaf subjects. The author recognizes the difficulties of drawing conclusions from tests that utilize language responses in a group whose major disability is language. She believes, however, that her experience with the deaf and the utilization of all forms of communication minimized this difficulty.

The fact that the average educational achievement of the deaf subjects used was approximately the fourth grade, as compared with a ninth- or tenth-grade achievement for the hearing control group, may furnish an explanation for the difference on tests requiring language responses. How to control this important variable is one that has stumped researchers in this field. The author implies that much more rigid experimentation is needed in this area.

The book is well written in a semi-popular style, as represented by the title, *Youth in a Soundless World*. A more descriptive title would have been "A study of Wechsler and Rorschach scores of 31 adolescent deaf girls."

SAMUEL A. KIRK  
University of Illinois

**Amino Acid Handbook.** Methods and results of protein analysis. Richard J. Block and Kathryn W. Weiss. Thomas, Springfield, 1956. 386 pp. Illus. \$10.50.

The first part of this handbook constitutes an excellent laboratory manual that gives, with experimental details, the procedures available for the analysis of proteins and determination of their com-

ponent amino acids. Chemical, microbiological, and chromatographic methods are covered, and the results and limitations in typical cases are presented. Two short chapters cover dietary requirements for amino acid and protein consumption in the United States.

The latter half of the book is devoted to a very comprehensive tabulation of the amino acid composition of about 160 proteins. The tables list method and results in the analysis of each protein by a large number of investigators. The accompanying bibliography, which gives 1300 references to the original literature, through 1955, should be of great value to protein chemists, and the handbook itself should be extremely useful to those concerned with nutritional aspects of protein chemistry.

**Archimedes:** vol. 12, *Acta Historica Scientiarum Naturalium et Medicinalium*. E. J. Dijksterhuis. Ejnar Munksgaard, Copenhagen, 1956. 420 pp.

This book is an English version of the author's *Archimedes* [in Dutch (Groningen, 1938)] and of articles that appeared in the Dutch periodical *Euclides* between 1938 and 1944.

In setting forth the mathematical arguments, E. J. Dijksterhuis employs a notation of his own devising, which is somewhat between the modern symbolic notation of T. L. Heath's English version and the nonsymbolic verbal mathematics of Paul Ver Eecke's literal French translation. The bulk of the work is a discussion of all the writings of Archimedes, proposition by proposition. As a rule, only the enunciation of the proposition is actually translated; the rest is generally paraphrased, summarized, and commented on. In addition, there are chapters on Archimedes' life and works and on the basic concepts and lemmas that he employs.

With this book, Dijksterhuis has put all students of Greek mathematics in his debt. The modern reader who approaches an author as profound as Archimedes needs every help he can get, and he is indeed fortunate, now, to be able to consult Dijksterhuis along with the standard editions of Heath and Ver Eecke.

The new work is so very valuable for what it seeks to do—that is, to make more understandable the actual mathematics of Archimedes—that it may seem ungracious to ask for more. Yet a consideration of Archimedes' work suggests many topics (some of them outside the boundaries of technical mathematics) which have not been adequately dealt with in any of the standard treatises on Archimedes. Among these are the factors

that determined the direction of Greek geometry and molded Archimedes' thinking; the peculiar insights that enabled him so decisively to break some (but not others) of the barriers of traditional geometry; the historical relations between numerical and geometric methods in applied science and the reason for the emphasis on the latter in the Greek development; the failure of Archimedes' followers, in antiquity, to advance his work (for example, with any quantitative treatment of specific gravity); the attitude of Archimedes (and antiquity, in general) on the sort of labor-saving machinery for which his work laid theoretical foundations; the preservation of Archimedes' thought in the Middle Ages, and the precise nature of the impact of his work on such men as Galileo and Newton at the beginning of the modern era.

Study on some of these topics is going forward; the fundamental work of Marshall Claggett in assessing the influence of Archimedes in the Middle Ages is a case in point. With the progress of such studies we shall have a clearer understanding of the position of Archimedes in the general history of science. Toward our understanding of Archimedes' achievement in the more restricted field of technical mathematics, Dijksterhuis has made a welcome and substantial contribution.

I. E. DRABKIN  
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**They've Got Your Number.** Robert Wernick. Norton, New York, 1956. 124 pp. Illus. \$2.95.

That the *Zeitgeist* influences the course of scientific inquiry and occasionally the findings and theoretical constructions of scientists is a key proposition in the sociology of knowledge.

The most valuable thing about this little book is that, in its own gag-laden and irresponsible way, it may force upon those psychologists who happen to read it a recognition of the fact that psychological testing as a field is heavily influenced by some of the social imperatives of our time and place.

Robert Wernick is probably right in contending that the cultural compulsives toward conformity and against privacy have energized the boom in psychological testing. Unfortunately he gives no evidence of having carried his thought a step further to the connection between the demand for conformity and the development of a bureaucratized mass society whose functioning seems to require members governed by routinized needs and motivated to the execution of predictable patterns of interaction.

That he avoids these, or any other, social-analytic implications of his subject is not really a matter of surprise. Although it touches upon serious matters, this is not a serious book. Rather, it belongs to that genre of "indignation pieces" which so many publishers are presently seeking and encouraging. And if indignation may be turned upon the "conspiracy of the professors," why so much the better in these days of counter-eggheadism.

Having raised the spectre of "conformity," Wernick vents the remainder of his vituperative gait on insisting that psychological tests (by which he seems largely to mean aptitude and personality questionnaires) are at any rate scientifically worthless.

Some portions of his critique of test-development methods are well taken, and one cannot but admire the skill with which he seems to have taken them from the very body of literature which he aspires to ridicule.

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## New Books

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# Meetings and Societies

## Midwest Regional State College Conference

The AAAS Science Teaching Improvement Program sponsored a 2-day conference on science and mathematics teacher education on the campus of Northwestern University, Chicago, Ill., 8-9 Mar. Presidents of the 25 state colleges in Illinois, Indiana, Iowa, Michigan, Ohio, and Wisconsin were invited to name two conference representatives, one each from science and mathematics. In addition, conference participants included representatives of the Chicago Teachers College and ten high-school science and mathematics teachers of the Chicago area. The purpose of the conference was to explore promising practices in science and mathematics teacher education.

Addresses were given at the general session by Harry Kelly, of the National Science Foundation, and J. W. Maucker, president of the Iowa State Teachers College and member of the AAAS-AACTE Joint Commission on the Education of Science and Mathematics Teachers. Kelly spoke on "The teacher of science" and Maucker, on "Teacher education and special area problems."

Short papers on current practices or projected programs were presented by representatives of seven of the state colleges and by invited conference participants from the University of Chicago, University of Illinois, Wayne State University, Michigan State University, University of Kansas, and the State University Teachers College, Oneonta, N.Y. Recommendations on desirable teacher education programs were prepared in discussion groups on general science, the biological sciences, the physical sciences, and mathematics.

G. Baley Price, Kenneth O. May, Jerry J. Kollros, and William MacNevin, regional consultants of the AAAS Science Teaching Improvement Program, and George G. Mallinson, of Western Michigan University, served as presiding officers of various sessions. Members of the planning committee for the conference were H. Glenn Ayre, Mallinson, Walter B. Welch, and John R. Mayor. M. Ira Dubins, of Northwestern University, and Sarah I. Cohn, of the AAAS

Science Teaching Improvement Program staff, were in charge of conference arrangements.

A report of the conference will be available, on request to AAAS Science Teaching Improvement Program, 1515 Massachusetts Ave., NW, Washington 5, D.C., after 15 Apr.

JOHN R. MAYOR  
*American Association for the  
Advancement of Science*

## Tau Beta Pi Association

The Tau Beta Pi Association, a new affiliate of the AAAS, admitted at the December 1956 meeting, is a national honor society in engineering. Founded in 1885 at Lehigh University, it now has 99 undergraduate chapters, 26 alumnus chapters, and more than 90,000 initiated members. Its purpose is "to mark in a fitting manner those who have conferred honor upon their alma mater by distinguished scholarship and exemplary character as undergraduates in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in the engineering colleges of America."

The two prime requirements for membership are high scholarship or eminent achievement in engineering and worthy character. Election to membership, either of graduate engineers or students, is accomplished only by vote of an undergraduate chapter. For students, the top eighth of the junior engineering class and the top fifth of the senior engineering class are eligible for membership consideration. A candidate's election from a scholastically eligible group is based on his character—his integrity, breadth of interest both inside and outside of engineering, adaptability, and unselfish activity. Tau Beta Pi believes that personal integrity transcends in importance scholarship, activity, and every other qualification.

The annual convention is the supreme legislative, executive, and judicial body of Tau Beta Pi. One convention vote is given to each undergraduate and alumnus chapter and to each of the 11 national officers. Between conventions, control and guidance of the association is

vested in an executive council, or board of directors, consisting of five alumnus members who are elected for 4-year terms by the convention. The secretary-treasurer and editor is the only full-time, paid officer of the association, and his office, at the University of Tennessee (Knoxville), is headquarters for the organization. Other national officers are appointed for 4-year terms by the executive council; they have supervision over specific areas of society activity.

The national quarterly magazine of Tau Beta Pi is *The Bent*; it was established in 1905. Each new initiate receives a 4-year subscription with his national initiation fee. Annual renewals and a life subscription plan provide for keeping alumnus members informed and encourage continued alumnus support of the association. No dues are charged, either national or chapter, following graduation. Present paid circulation of *The Bent* is in excess of 25,000. Editorial material is limited to general articles of nontechnical, professional interest and to news of the association.

The national organization conducts several major projects aimed at helping young engineers in their professional development. A fellowship program has been operated since 1929 and has made possible a year of graduate study in engineering for 145 members. More than \$114,000 has been awarded in fellowships during this period, from association funds, alumnus contributions, and industrial donations. Two firms, the Louis Allis Company of Milwaukee and the Minneapolis-Honeywell Regulator Company, have cooperated with Tau Beta Pi over the past several years in this fellowship program. These industrial stipends are awarded by Tau Beta Pi in the same fashion as its own graduate fellowships. Five or six fellowships are awarded each year, each grant currently being \$1500. The chief qualifications for winning any Tau Beta Pi fellowship are financial need and promise of substantial achievement in research, in practice, or in teaching.

Under Tau Beta Pi's student loan program, undergraduate and graduate-student members may borrow as much as \$500 from the association for 3 years, at low interest rates. Since inauguration of the program in 1931, more than 350 loans have been made for a total of more than \$80,000.

Another national project of Tau Beta Pi is the pledge essay program. Each undergraduate who is elected to membership is required to write an essay, preferably on a nontechnical subject, for submission to his chapter. These papers are judged locally, and the winner is entered in a national contest. Semiannual national prizes, ranging up to \$100 for first place, are awarded by alumnus judging



committees. A recent supplement to the essay program is the Greater Interest in Government contest, for which national prizes are provided by a fund donated by several members. Student papers on American citizenship, American government, or the responsibility of engineers to take an active part in civic and governmental affairs, are eligible for local prizes and national awards in the two programs. Top prize papers are published in *The Bent*.

At the chapter level, Tau Beta Pi conducts many projects designed to encourage high scholarship, high standards of moral conduct, and service to alma mater. Chapter project work takes advantage of the combined talents of groups of superior students in furthering Tau Beta Pi's broad objectives.

ROBERT H. NAGEL  
*University of Tennessee, Knoxville*

## Quantitative Biology

The 22nd Cold Spring Harbor Symposium on Quantitative Biology will be held 3-12 June. The topic of the meetings will be "Population studies: animal ecology and demography." Individual sessions will deal with the historical aspects of human populations, demographic analysis of human populations, studies of experimental populations, ecological aspects of natural populations, the structure of communities, and the population as a unit of evolution. The symposium is open to all who are interested, but because of space limitations it is important to make advance reservations. For further information, address the Biological Laboratory, Cold Spring Harbor, N.Y.

## American College of Cardiology

The American College of Cardiology will hold its sixth annual meeting at the Hotel Willard in Washington, D.C., 15-18 May. The general topic of the meeting will be diagnostic methods in cardiology. The scientific sessions will feature acute and chronic pericarditis; graphic, laboratory, and roentgenologic methods in cardiology, including vectorcardiography, electrocardiography, and catheterization; a postgraduate symposium on congenital heart disease; and a seminar on open heart surgery.

Simon Dack of New York will preside, with the joint collaboration of Aldo A. Luisada, chairman of the Scientific Program Committee, Division of Cardiology, Chicago Medical School. There will be many scientific exhibits on cardiology and related subjects, organized by Milton S. Saslaw of Miami, Fla. Seymour Fiske, New York, is general chairman, with

Irving Brotman of Washington, D.C., and George W. Calver, trustee of the college and physician to the Congress of the United States, in charge of local arrangements. Further information may be obtained from Philip Reichert, secretary, American College of Cardiology, Empire State Building, New York 1, N.Y.

## Histochemistry, Tissue Culture, and Anatomy

The Histochemical Society will meet at the University of Maryland School of Medicine, Baltimore, 15-16 Apr. Headquarters will be established at the Lord Baltimore Hotel. A symposium has been arranged on "Localization in histochemistry." The meetings will be held in Chemical Hall and the Administration Building.

The Tissue Culture Association will also meet at the medical school at almost the same time, 16-17 Apr., in association with the meeting of the American Association of Anatomists, which is scheduled for 17-19 Apr. Part of the first day of the Tissue Culture program will be devoted to a conference topic, papers by invitation, on "Growth, stimulation and inhibition," chairman, Joseph F. Morgan. The remainder of the sessions will consist of free papers, many of which will complement the conference topic.

## Solid-State Phenomena

Internationally known specialists in solid-state phenomena are scheduled to participate in the seventh of a series of international symposia sponsored by the Microwave Research Institute of the Polytechnic Institute of Brooklyn, 23-25 Apr., in the auditorium of the Engineers Societies Building in New York. Entitled "The role of solid-state phenomena in electric circuits," the symposium will stress the phenomenological description of new or unexploited effects that may be useful in electric circuits. The program has been arranged by the Microwave Research Institute in cooperation with the Institute of Radio Engineers, and is cosponsored by the Air Force Office of Scientific Research, the Signal Corps Engineering Laboratories, and the Office of Naval Research.

## Bacteriologists

The 57th general meeting of the Society of American Bacteriologists will convene in Detroit, Mich., on the evening of 28 Apr., with an address by A. A. Mossel, University of Utrecht, the Netherlands. Attendance at the meeting is

expected to be around 3000. A total of 456 scientific papers will be divided among five divisions of microbiology: general, medical, agricultural and industrial, public health, and physiology. Six sessions will be in progress simultaneously during the morning and afternoon meetings of each of the 4 days, 29 Apr. through 2 May. Three round-table or seminar programs are scheduled for each of the evening sessions, 29 and 30 Apr.

The president's reception in honor of Perry Wilson of the University of Wisconsin will be held on 1 May at the Sheraton-Cadillac Hotel. The convention will adjourn on the afternoon of 2 May with an address by the Eli Lilly award winner.

## Society Elections

■ International Association for Dental Research: pres., Reidar F. Sognnaes, Harvard University Dental School; past pres., Joseph F. Volker, University of Alabama; pres.-elect, Ned B. Williams, University of Pennsylvania; v. pres., Hamilton B. G. Robinson, Ohio State University; sec.-treas., Dan Y. Burrell, University of Kentucky.

■ National Science Teachers Association: pres., Glenn O. Blough, University of Maryland; pres.-elect, Herbert A. Smith, University of Kansas; sec., H. M. Louderback, Lewis and Clark High School; exec. sec., Robert H. Carleton, 1201 16th St., NW, Washington 6, D.C.; treas., Robert T. Lagemann, Vanderbilt University.

■ AAAS, Mobile, Alabama, Chapter: pres., H. L. J. Marshall; sec., Kurt Tauss, 309 Wayne Place, Mobile, Ala.; treas., P. H. Yancey, S.J.

■ American Astronautical Federation: pres., Norris R. Peery; v. pres., Carroll L. Evans, Jr.; sec., Dale R. Smith; treas., James French.

## Forthcoming Events

### May

7. International Hydrographic Conf., 7th, Monte Carlo, Monaco. (International Hydrographic Bureau, Quai des Etats-Unis, Monte Carlo.)

7-24. World Health Assembly, 10th, Geneva, Switzerland. (World Health Organization, Palais des Nations, Geneva.)

8-9. European Federation of Chemical Engineering, 12th, Amsterdam, Netherlands. (Federation, Frankfurt/Main, 7, Germany.)

8-11. American Astronomical Soc., Cambridge, Mass. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38.)

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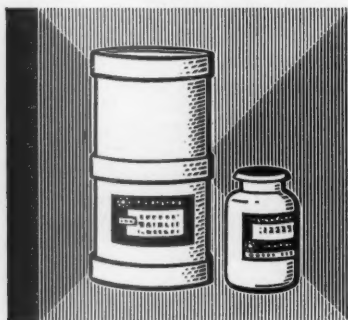
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8-11. American Helicopter Soc., 13th annual, Washington, D.C. (H. M. Lounsbury, AHS, 2 E. 64 St., New York 21.)

9. Dietary Essential Fatty Acids, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

9-10. Microwave Ferrites and Related Devices and Their Applications, New York, N.Y. (S. Weisbaum, Bell Telephone Laboratories, Murray Hill, N.J.)

9-10. Operations Research Soc. of America, 5th annual, Philadelphia, Pa. (M. L. Ernst, P.O. Box 2176, Potomac Sta., Alexandria, Va.)

9-11. Drugs in Psychotherapy, internatl. symp., Milan, Italy. (Secretary, Pharmacology Inst., Via Andrea del Sarto 21, Milan.)

9-11. Virginia Acad. of Science, Old Point Comfort. (F. F. Smith, Box 1420, Richmond, Va.)

9-12. American Psychoanalytic Assoc., Chicago, Ill. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

10-11. Indiana Acad. of Science, Turkey Run State Park, Ind. (H. Crull, Dept. of Mathematics, Butler Univ., Indianapolis 7.)

10-11. Vocational Training and Rehabilitation of the Mentally and Physically Handicapped, Woods Schools Conf., Chicago, Ill. (J. M. MacDonald, Woods Schools, Langhorne, Pa.)

12-13. International Soc. of Bronchoesophagology, cong., Philadelphia, Pa. (C. L. Jackson, 1901 Walnut St., Philadelphia 3.)

12-16. Electrochemical Soc., Washington, D.C. (H. B. Linford, 216 W. 102 St., New York 25.)

12-16. Institute of Food Technologists, annual, Pittsburgh, Pa. (C. S. Lawrence, IFT, 176 West Adams St., Chicago 3, Ill.)

13-15. Industrial Waste Conf., 12th Lafayette, Ind. (D. E. Bloodgood, Purdue Univ., Lafayette.)

13-15. Radiation Research Soc., annual, Rochester, N.Y. (A. Adelman, Nuclear Science and Engineering Corp., P.O. Box 10901, Pittsburgh 36, Pa.)

13-15. Recent Developments in Research Methods and Instrumentation, symp., Bethesda, Md. (J. A. Shannon, National Institutes of Health, Bethesda.)

13-15. Structure of Electrolytic Solutions, NSF symp., Washington, D.C. (H. B. Linford, Electrochemical Soc., 216 W. 102 St., New York 25.)

13-16. American Orthodontic Assoc., New Orleans, La. (S. D. Goal, 1037 Maison Blanche Bldg., New Orleans.)

13-16. Semiconductor Symposium, 5th annual, Washington, D.C. (H. M. Pollack, Semiconductor Div., RCA, 415 S. 5 St., Harrison, N.J.)

13-17. American Psychiatric Assoc. annual, Chicago, Ill. (D. Blain, APA, 1785 Massachusetts Ave., NW, Washington 6.)

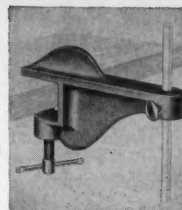
13-17. Inter-American Symposium on the Peaceful Uses of Nuclear Energy, Brookhaven, L.I., N.Y. (S. Tucker, Brookhaven National Lab., Brookhaven, L.I.)

14-16. Industrial Nuclear Technology Conf., Chicago, Ill. (L. Reiffel, Armour Research Foundation, Illinois Inst. of Technology, 10 West 35 St., Chicago 16.)

14-16. International Soc. of Audiology,

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cong., St. Louis, Mo. (S. R. Silverman, 818 S. Kingshighway, St. Louis 10.)

14-18. Biochemistry of Cancer, symp. of International Union against Cancer, London, England. (E. Boyland, Chester Beatty Research Inst., Royal Cancer Hospital, Fulham Rd., London, S.W.3.)

15-16. Space Age Symposium, Southern Research Inst., Birmingham, Ala. (R. D. Osgood, Jr., Southern Research Inst., 917 S. 20 St., Birmingham 5.)

15-18. American College of Cardiology, Washington, D.C. (S. Fiske, 150 E. 71 St., New York 21.)

15-18. Work and the Heart Medical Conf., Milwaukee, Wis. (E. L. Belknap, Dept. of Occupational and Environmental Medicine, Marquette School of Medicine, Milwaukee.)

16-17. Space Age Symp., Southern Research Inst., Birmingham, Ala. (R. D. Osgood, Jr., Southern Research Inst., 2000 Ninth Ave. South, Birmingham 5.)

16-18. Engineering Industries Exposition, New York, N.Y. (H. Becher, New York State Soc. of Professional Engineers, 1941 Grand Central Terminal Bldg., New York 17.)

16-18. Society of Naval Architects and Marine Engineers, spring, Long Beach, Calif. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6.)

17. Maryland Acad. of Sciences, annual, Baltimore, Md. (T. King, Maryland Acad. of Sciences, Enoch Pratt Free Library Bldg., Baltimore 1.)

17-19. American Inst. of Industrial Engineers, 8th annual, New York, N.Y. (J. L. Southern, AIIE, 145 N. High St., Room 303, Columbus 15, Ohio.)

19-21. Heat Transfer and Fluid Mechanics Inst., Pasadena, Calif. (P. P. Wegener, Jet Propulsion Lab., California Inst. of Technology, 4800 Oak Grove Dr., Pasadena 3.)

19-23. American Assoc. of Cereal Chemists, annual, San Francisco, Calif. (C. L. Brooke, Merck & Co., Inc., Rahway, N.J.)

19-24. National Conf. on Social Welfare, annual, Philadelphia, Pa. (F. Schmidt, NCSW, 22 W. Gay St., Columbus 15, Ohio.)

20-21. Society of American Military Engineers, annual, Washington, D.C. (National Headquarters, SAME, 808 Mills Bldg., Washington 6.)

20-22. International Voice Conf., Chicago, Ill. (H. Von Leden, 30 N. Michigan Ave., Chicago 2.)

20-24. Correctional Psychiatry and Group Counseling, joint institute, Poughkeepsie, N.Y. (P. H. Hoch, Commissioner of Mental Hygiene, State Office Bldg., Albany, N.Y.)

20-24. Mass Spectrometry, New York, N.Y. (R. A. Friedel, U.S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.)

20-25. International Conf. of Epizootics, annual, Paris, France. (12, rue de Prony, Paris 17<sup>e</sup>.)

20-31. International Federation of Agricultural Producers, 9th general assembly, Lafayette, Ind. (IFAP, 712 Jackson Pl., NW, Washington, D.C.)

21-25. American Assoc. on Mental Deficiency, Hartford, Conn. (T. L. McCulloch, Letchworth Village, Thiells, N.Y.)

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22-24. American Inst. of Chemists, annual, Akron, Ohio. (L. Van Doren, AIC, 60 E. 42 St., New York 17.)

22-24. American Soc. for Quality Control, annual, Detroit, Mich. (L. S. Eichelberger, A. O. Smith Corp., Milwaukee 1, Wisc.)

22-25. International Scientific Radio Union, national spring mtg., Washington, D.C. (J. P. Hagen, U.S.A. National Committee URSI, National Acad. of Sciences, 2101 Constitution Ave., NW, Washington 25.)

23-25. Acoustical Soc. of America, New York, N.Y. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

25-26. International Cong. for the Study of the Bronchi, Lisbon, Portugal.

(F. Lopo de Carvalho, 138 rua de Junqueira, Lisbon.)

25-28. International Cong. of Acupuncture, 9th, Vienna, Austria. (Austrian Assoc. for Acupuncture, 57 Schwenderstrasse, Vienna.)

26-30. Special Libraries Assoc., annual, Boston, Mass. (Miss M. E. Lucius, SLA, 31 E. 10 St., New York 3.)

29-2. American College of Chest Physicians, annual, New York, N.Y. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago 11, Ill.)

30-31. Rheology of Elastomers, conf., Welwyn Garden City, Herts., England. (N. Wookey, British Soc. of Rheology, 52, Tavistock Rd., Edgware, Middlesex, England.)

30-1. American Acad. of Dental Medicine, 11th annual, Boston, Mass. (R. Diamond, 100 Boylston St., Boston.)

30-1. American Malacological Union, Pacific meeting, Santa Barbara, Calif. (Miss M. C. Teskey, P.O. Box 238, Marinette, Wis.)

30-1. Endocrine Soc., 39th annual, New York, N.Y. (H. H. Turner, 1200 N. Walker St., Oklahoma City 3, Okla.)

31-2. American Soc. for the Study of Sterility, New York, N.Y. (H. Thomas, 920 S. 19 St., Birmingham 5, Ala.)

31-2. Social Medicine, internatl. cong., Vienna, Austria. (T. Antoine, Spitalgasse 23, Vienna 9.)

31-2. Society for Applied Anthropology, annual, East Lansing, Mich. (W. F. Whyte, New York State School of Industrial and Labor Relations, Cornell Univ., Ithaca, N.Y.)

## June

1-2. American Diabetes Assoc., 17th annual, New York, N.Y. (ADA, 1 E. 45 St., New York 17.)

1-2. Soc. for Investigative Dermatology, annual, New York, N.Y. (H. Beerman, 255 S. 17 St., Philadelphia 3, Pa.)

2-6. Air Pollution Control Assoc., golden anniversary, St. Louis, Mo. Jointly with American Meteorological Soc., American Soc. of Heating and Air Conditioning Engineers, American Inst. of Chemical Engineers, and American Soc. of Mechanical Engineers. (H. C. Ballman, APCA, 4400 Fifth Ave., Pittsburgh 13, Pa.)

2-7. Society of Automotive Engineers, summer, Atlantic City, N.J. (Meetings Division, SAE, 29 West 39 St., New York 18.)

2-8. International Cong. of Photobiology, 2nd, Turin, Italy. (G. Matli, Istituto di Fisica dell'Universita di Torino, Via Pietro Giuria 1, Corso Massimo d'Azeglio 46, Turin.)

3-5. American Soc. of Refrigerating Engineers, Miami Beach, Fla. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

3-5. Chemical Inst. of Canada, 40th annual, Vancouver, B.C. (CIC, 18 Rideau St., Ottawa 2, Ont.)

3-7. American Medical Assoc., annual, New York, N.Y. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

3-7. American Soc. of Civil Engineers, Buffalo, N.Y. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

3-7. Hospital Cong., 10th international, Lisbon, Portugal. (J. E. Stone, 10 Old Jewry, London, E.C.2, England.)

3-8. Microbiological Inst., 10th annual, Lafayette, Ind. (C. L. Porter, Dept. of Biological Sciences, Purdue Univ., Lafayette.)

3-12. Quantitative Biology, 22nd Cold Spring Harbor Symp., Cold Spring Harbor, N.Y. (B. Wallace, Biological Laboratory, Cold Spring Harbor.)

4-9. Blood Circulation, international symp., London, England. (D. G. James, c/o 11 Chandos St., London, W.1.)

5-7. Therapeutics, 5th international cong., Utrecht, Netherlands. (F. A. Nelemens, Bureau Provisoire, Vondellaan 6, Utrecht.)

(See issue of 15 March for comprehensive list)

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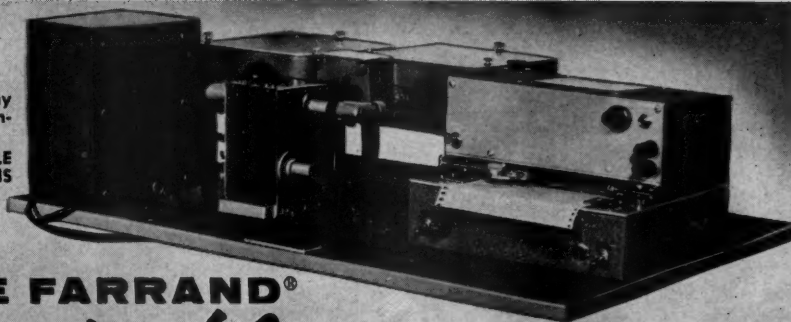
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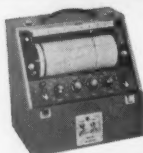
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National Bureau of Standards

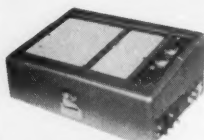
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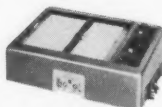
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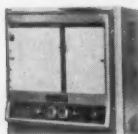
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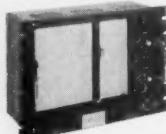
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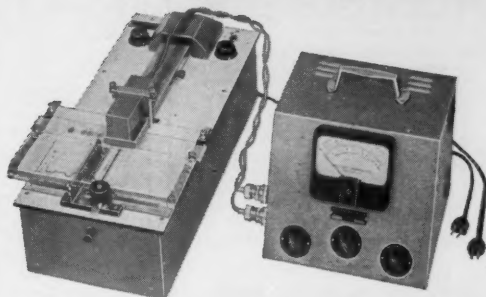
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A photoelectric precision instrument for the rapid and convenient evaluation of strips and sheets of filter paper in partition chromatography and paper electrophoresis.

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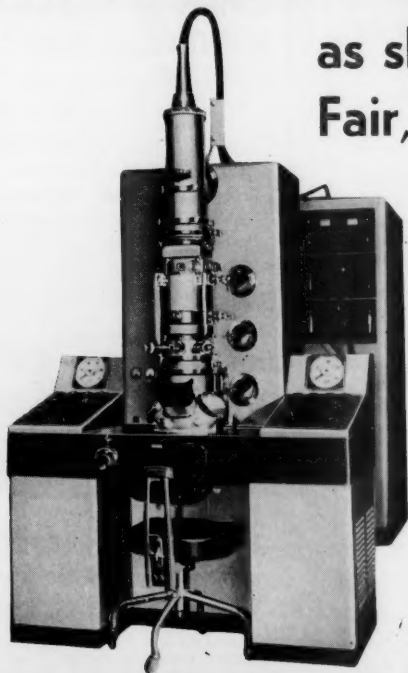
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as shown at the World Trade  
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The superior performance of this new instrument results from: Its compensated electron optical system; its freedom from astigmatism; the reduction of chromatic field aberration coefficient to approximately one-tenth, the axial chromatic aberration coefficient to about one-third, and spherical aberration coefficient to approximately one-fifth that found in other microscopes.

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## POSITIONS WANTED

Biochemist, Danish; age 27. Wants employment at extra-European university. Experienced in biological kinetics. Apply Box 121, SCIENCE. X

(a) Chemist; Ph.D.; 3 years of teaching; 7 years as senior chemist and production superintendent in industry. (b) Physician; Ph.D., physiology; 14 years' experience as director, medical research, Medical Bureau, Burnside Larson, Director, 900 N. Michigan Avenue, Chicago. X

Cytologist, Ph.D. in June; 7 years' research experience in animal cancer chemotherapy and 3 years' experience in tissue culture; publications. Interested in industrial organization. Box 122, SCIENCE. X

M.D., 42, background pathology, cancer research, endocrinology-geriatrics, metabolic interrelationships, pathophysiology/prophylactic aspects; numerous publications. Desires unusual teaching/research opportunity. Box 124, SCIENCE. X

Ph.D. with college and secondary school experience desires college zoology position. Available June. Box 69, SCIENCE. 4/19

Physiologist-Chemist, Ph.D.; 3 years of teaching experience and 6 years of industrial experience, physiology, clinical chemistry, endocrinology, and toxicology. Desires research position, or college teaching and research. Box 123, SCIENCE. X

## POSITIONS OPEN

Bacteriologist; 400-bed hospital, Chicago; \$5000-\$6000; M.A. desirable. Hospital experience essential. Box 85, SCIENCE. 4/5, 12

(a) Medical Director; preferably one who completed training at least 5 years ago; duties: professional correspondence, lecturing, technical consultation, supervising clinical studies; important pharmaceutical company; university city, West. (b) Production Supervisor qualified to supervise staff of 60 making tablets, sterile solutions, and so forth; rapidly expanding company; fine research and library facilities; up to \$12,000; Midwest. (c) Endocrinologist to head endocrinology section concerned with problems related to adrenals; large pharmaceutical company; university city, Midwest. (d) Senior Research Associate, division of physiology and pharmacology, pharmaceutical company; preferably Ph.D. in physiology with training in biochemistry; East. (e) Well-Qualified Young Physician to direct editorial department, pharmaceutical company; unusual opportunity; East, S-2 Medical Bureau, Burnside Larson, Director, 900 N. Michigan Avenue, Chicago. X

Opening in the Department of Radiology Isotope Laboratory for a responsible individual; academic appointment; research opportunity; Position and salary commensurate with experience and background; minimum requirement, B.S. in physics. Submit replies to Dr. W. S. Moos, University of Illinois, 840 South Wood Street, Chicago 12, Illinois. 4/12, 19

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**POSITIONS REQUIRING DEGREES IN MEDICINE OR SCIENCE:** (a) Biochemist; Ph.D. for full-time individual research in neurochemistry; important eastern university medical school. (b) Bacteriologist; B.S. or M.S., well-organized laboratories, very large general hospital; important university medical center; Midwest. (c) Biochemist, M.S.; well-staffed and equipped laboratories, 600-bed voluntary general hospital; Midwest. (d) Pharmacology-Physiology Instructor; young Ph.D.; eastern medical school, important hospital affiliations; about \$5500. (e) Clinical Chemist; supervise department, well-organized, busy laboratory; hospital to double present 200-bed capacity shortly; university medical center; Midwest. Woodward Medical Bureau, 185 N. Wabash, Chicago. X

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In your letter tell us your age, education, experience, and salary level.

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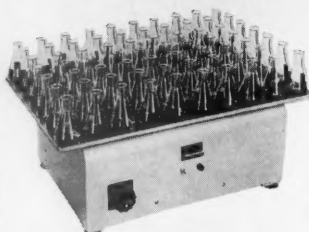
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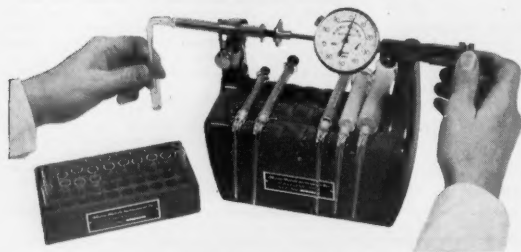


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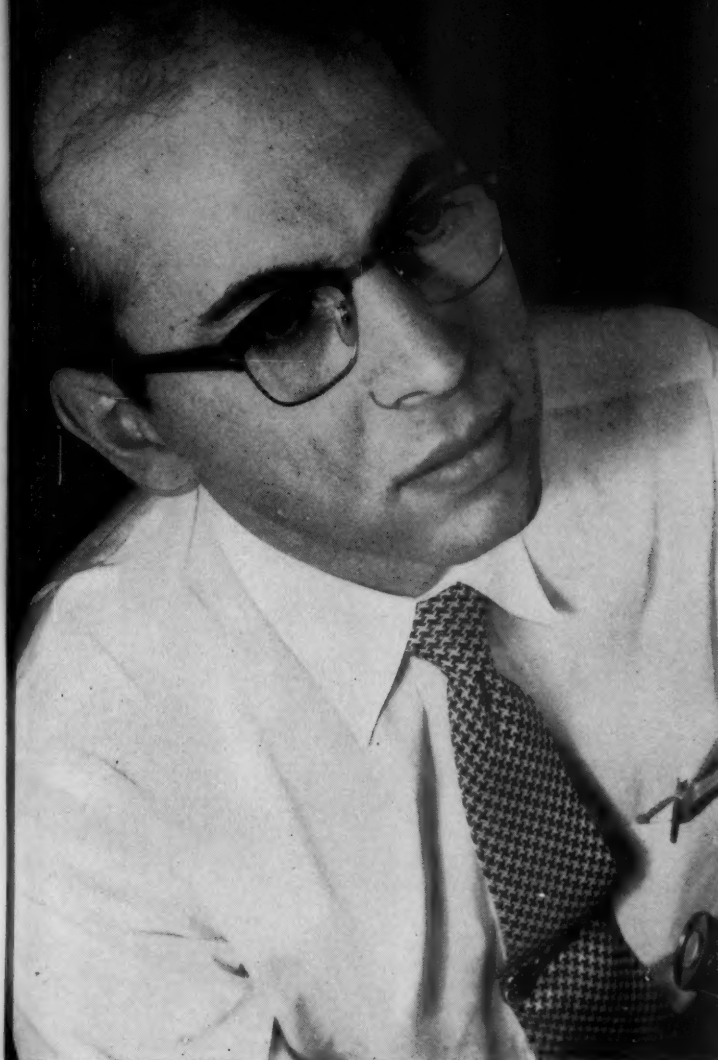
B-507

**JAMES G. BIDDLE CO.**

Electrical & Scientific Instruments

1316 ARCH STREET, PHILADELPHIA 7, PA.

Dr. William C. Dash, B. S., Lehigh University (1946), Ph.D., Cornell University (1952), has been a member of the *Semiconductor Studies Section* at the General Electric Research Laboratory for five years, investigating optical absorption and perfection of semiconductor crystals.



## Looking into silicon

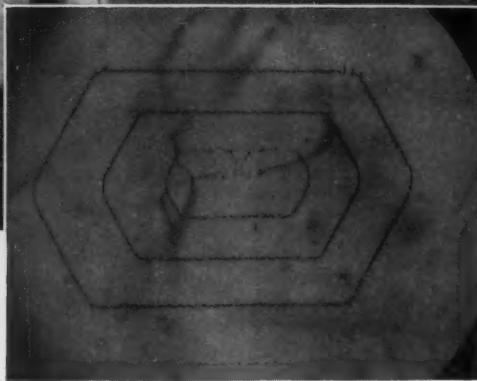
**Dr. William C. Dash of General Electric develops a new technique for studying dislocations in silicon crystals**

Silvery wafers of silicon used in semiconductor research — and in the manufacture of transistors — are as opaque as a brick wall to visible light, but highly transparent to infrared. Dr. William C. Dash of the General Electric Research Laboratory has adapted the "snooperscope," an infrared-sensitive device developed during World War II, as a convenient means of looking into silicon crystals.

Recently Dr. Dash and his associates devised a method of precipitating copper along the rows of out-of-line atoms inside silicon crystals so that these flaws — called *dislocations* — can be seen by the snooperscope. Since physicists now explain many aspects of crystal behavior — how they grow and why they bend

— in terms of dislocations, the Dash technique is an important new tool for learning more about the solid state. Dislocation patterns predicted by theory have actually been seen for the first time on the screen of Dr. Dash's snooperscope.

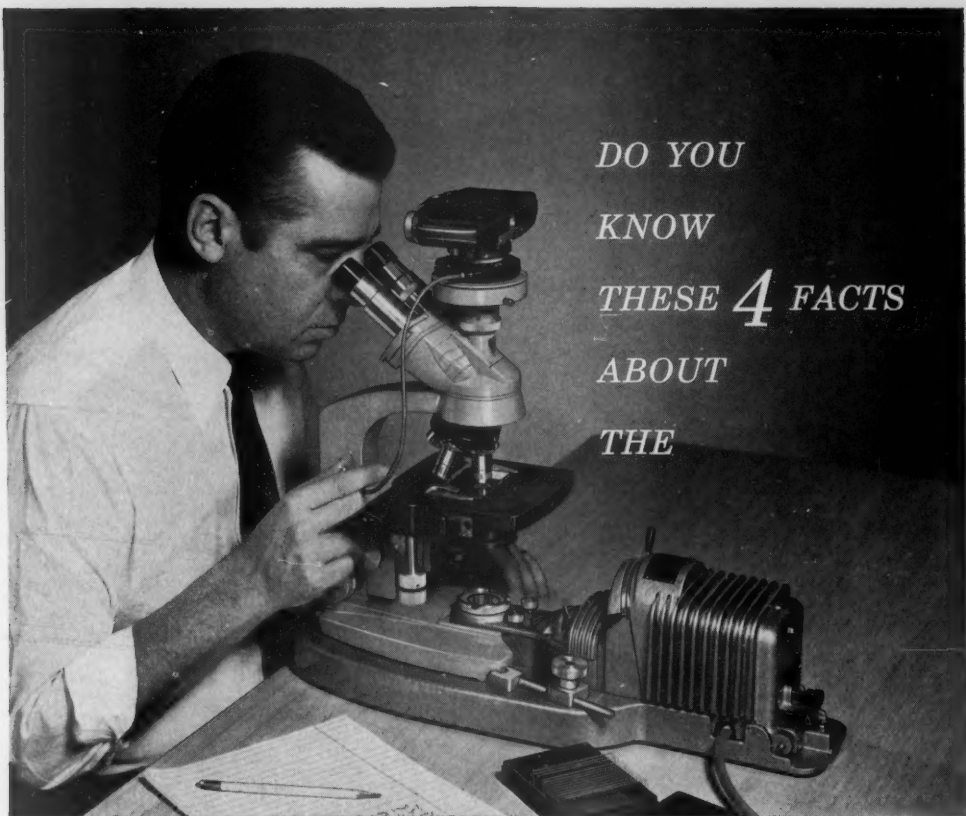
At General Electric, such research is motivated by a belief that providing scientists with the tools, the incentives, and the freedom to seek out new knowledge is the first step toward progress for everyone.



Infrared light passes through silicon and reveals pattern of dislocations on the screen of the "snooperscope."

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KNOW  
THESE 4 FACTS  
ABOUT  
THE



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